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CIVIL ENGINEERING

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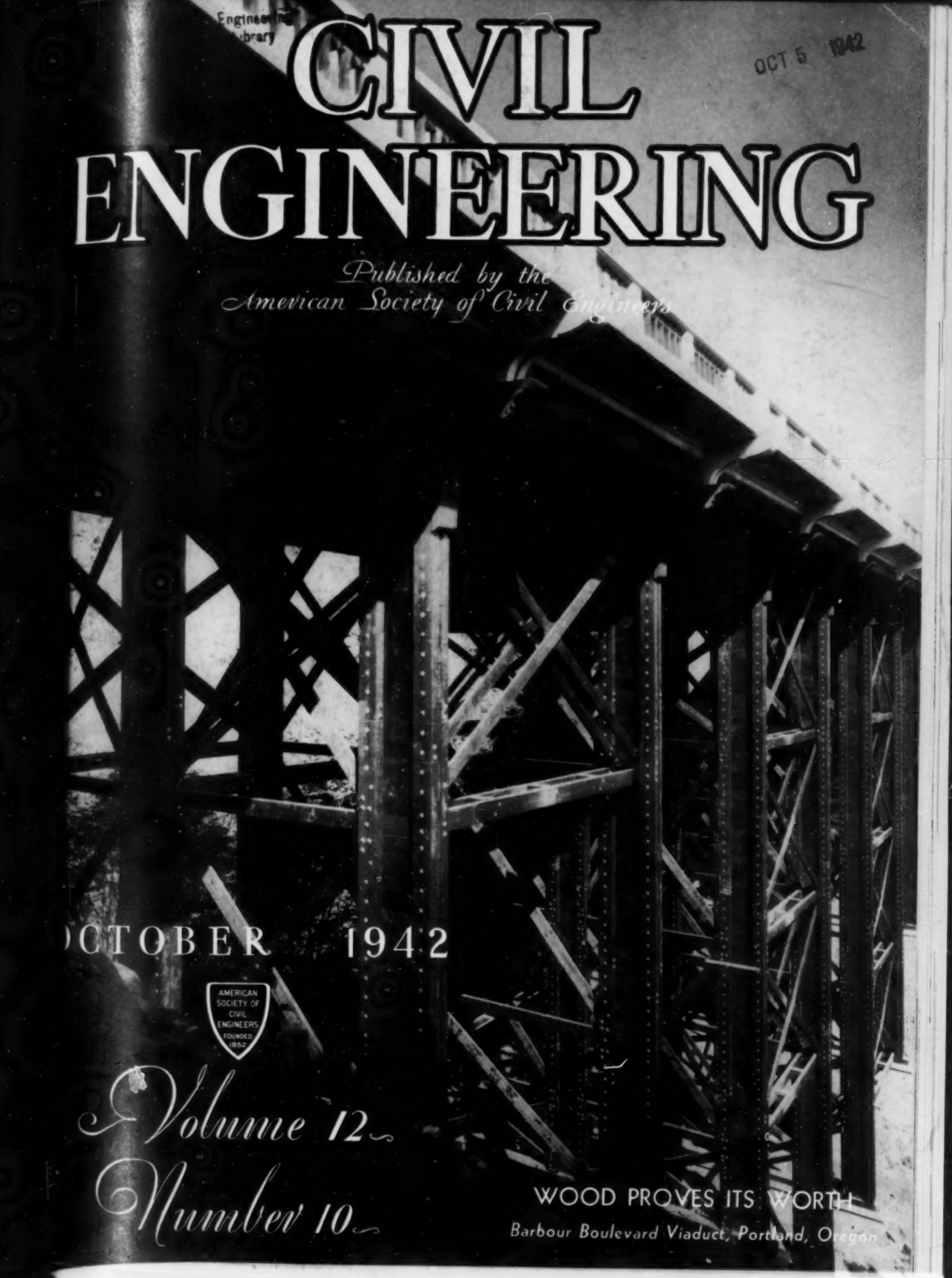

OCTOBER 1942

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

Volume 12
Number 10

WOOD PROVES ITS WORTH

Barbour Boulevard Viaduct, Portland, Oregon

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Interested readers of Raymond advertisements are familiar with these closing words, "Whether your projects are large or small, nearby or distant, your inquiries will receive prompt attention." For the present, this happy ending to our story must be deleted. Uncle Sam must not be kept waiting. He is America's number one customer. His time is our time and your time. In aiding him in his business of winning the war, our engineers are giving their first and constant attention to Government representatives and their projects. ● However, this we can promise. Your requests for service and information will be tabled directly beneath Uncle Sam's. We will get to you as promptly as possible, and we will continue to provide the expert advice and experienced workmanship that have made Raymond a leader in the foundation field. ● And that happy ending of ours is only being shelved for the duration. We've filed it away – verbatim – for future use.

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Building Design as an Art

By JOHN W. PICKWORTH, M. AM. SOC. C.E.
CONSULTING ENGINEER, WEISKOPF AND PICKWORTH, NEW YORK, N.Y.

THE world has long extolled the genius of engineers and likes to admire and to credit to pure engineering skill such monuments as dams and bridges. The general public finds majesty and beauty in these, and that is perhaps because where engineers have adhered to the simpler forms, even people untrained in science can perceive how these structures perform their functions. For all their size, viewed at a distance the Golden Gate and the George Washington bridges appear as two-dimensional pole and clothesline affairs. If brevity is the soul of wit, simplicity is the soul of beauty.

Buildings Are Achievements.—Modern buildings are no less triumphs of engineering art and skill. They are less easy for the layman to understand, being by nature complex three-dimensional structures. So the completed works are admired or criticized by the public according to the external architectural treatment—or, in other words, for the clothes they wear. This is true of buildings of the present era.

Buildings of earlier times were essentially simple in nature, and all the details of their design and construction were directed generally by a single individual. Such a master was Sir Christopher Wren. He was a giant—but he is representative of a class not possible in our times, a class of men who were each able to become in the short span of life, architect, engineer, builder, and artisan all in one.

Metal Has Become a Factor.—There is a basic reason why the present era is so different. Previously, so-called permanent construction was made up principally of compressive material. Masonry was used for foundations, walls, pillars, columns, arches, domes, buttresses, and even as beams and lintels where large enough stones were obtainable. The introduction into building construction of metal, with its tensile properties, and its availability in ever-increasing quantity and in a variety of shapes and sizes, has opened fields of human specialization too wide to be mastered in detail by any one man.

All this has naturally led men to separate into groups that live and work in particular fields of endeavor. Each field must contribute its peculiar product for use in the modern building. Coincidentally science has contributed utilities deemed essential to the comfortable use of our buildings and these also must be incorporated into the scheme of design. As the complexities increase, the major groupings of men find themselves dividing into minor groupings, a place in one of which offers a man ample scope for the life-long application of his talents.

Many Talents Combine.—So we find today that instead of one master builder, one Sir Christopher Wren, we require architects, engineers, and contractors or builders. The architect who plans the use and final appearance of the structure has become the coordinator and must provide a clearing house or forum where planning can be systematized and where allocations of required space for structural parts and utilities can be agreed upon. The engineering profession must bring specialists to this planning board to fix the requirements for foundation, skeleton, floor construction, elevators, plumbing, heating, ventilating, lighting, and communication. In all this there must be a constant consciousness of the abilities and limitations of the building contractor and his corps of subcontractors who will do the actual work at the site.

Now all this specialization has encouraged competition because the individual takes pride in his personal accomplishments and because each group must necessarily cultivate an esprit de corps. This competition in turn has aided advancement. Often, however, it creates rivalry, and if unbridled, leads to animosity and antagonism. Each individual contributing some vital part to a building is inclined to look upon the finished structure as a simple monument to his own art or to his personal skill.

Cooperative Effort Is Essential.—A modest appreciation of the fact that no one person can contribute more than a small, even if vitally essential, part toward the whole accomplishment need not stifle the understandable and proper urge to say "I designed that building," providing that the audience has a broad enough understanding of the remark. With more apparent justification an engineer can look at a bridge he has planned, swell his chest, and declare "I designed that!" A bridge is probably wholly an engineering creation, and generally

the designer has not been cramped by the limitations of space and other factors which circumscribe building construction. The appearance of the finished product boldly proclaims the engineering solution to the problem.

This is a satisfaction not accorded to the engineer engaged in building work. The complex internal functions of the modern building naturally require a framework which most usually is not in itself a thing of beauty. The several engineers have used every effort to occupy minimum space, deliberately cramping their work to make it as unobtrusive as possible. Their cleverness lies in so designing that their work may be hidden. The net result is the finished building, which, clothed in its architectural covering, with interior decoration appropriately chosen for the various rooms, may be deemed magnificent. Such is the effect in our most monumental structures.

Who Gets the Credit?—All this leads to a peculiar situation which affects the engineer engaged in building construction. It affects his relationship with his brother the bridge engineer, with his professional associates, and with the public. When a building is completed, the engineers are apt to be forgotten. Their work does not strike the eye of the beholder. The world at large is generous and likes to give credit but cannot in the rush of human affairs delve deeply into the matter of each individual contribution. It is natural and proper that the architect of record should represent the group he coordinates and that he should be the recipient, for them as well as for himself, of any honors that may be bestowed.

So it behooves the engineer who chooses to engage in building work to recognize modestly that no matter how vital his part in the creative task may be, his chief satisfaction must come from a job well done, with only such approbation as he may get from his intimate associates. The young engineer who finds this situation disheartening should realize that properly marrying a profession means divorcing self.

Collaboration from the Start.—It may be of interest to record the general principles of procedure that prevail and serve well in the field of modern building design. The most important rule is that the engineer should start his work of cooperative planning at the earliest possible moment. As soon as the architect has prepared his first small-scale schematic sketches, it is time for the experienced structural and foundation man to come into the picture. It is then that, relying on his experience and judgment rather than on figures, he can make his most valuable contribution by locating all major supports such as columns, trusses, and girders. It is then that the best type of floor system should be selected with due consideration of alternates, which because of changing market conditions may prove economical or otherwise more satisfactory when it comes time to let the contract.

If these engineering studies are deferred, the architect may in the meantime commit himself to features that are expensive without having any basic advantage. Collaboration at the earliest possible moment brings the best results. The engineer should produce sketches showing typical parts of the projected skeleton and establishing the limiting sizes of members. With a knowledge of approximate loads and of general ground conditions, he should begin his foundation studies. Prompt exchange of such information between architect and engineer permits teamwork to begin, and from then on they should work hand in hand.

Details Are Important.—It is the engineer's duty to try consistently to realize the architect's dreams, securing the necessary strength by the use of load-carrying members of the smallest size consistent with true economy. Beams or girders which establish the depth of the waste space that must exist between ceiling and floor should be kept shallow. Shallow beams require more material in themselves than do deep ones, but almost any expenditure per member is justified if it accomplishes a reduction in the building cubage.

The preparation of the general architectural plans and elevations should be almost exactly paralleled in time by the preparation of framing plans and column schedules, as well as heating, ventilating, plumbing, and other utility layouts. While it is in a sense true that tier buildings are planned from the top down, each layer having to support all above it, they are actually built from the bottom up. So it behooves the engineer to determine his loads at an early date and from those his foundation design so that work in the field can be started.

Time is of the essence, since idle property is an expense. So logically the foundations are often being installed while the plans for the superstructure are still in a very incomplete state.

Where Ability Counts.—It is obvious from all this that great dependence is placed on the judgment of those responsible for the engineering design of buildings. Major commitments are made prior to the completion of the computations. This tends to emphasize the fact that engineering is an art. It is an art—based on science.

Too often it is believed by outsiders that building frames are laid out by beam and column men, each armed with a slide rule and handbook. It takes scientific knowledge to enable a man to compute the proper size of beam to carry a certain load on a given span. But it is exercising the art of engineering to start with a plain piece of paper and determine where the beam should be placed. The science can be taught; the art must be learned.

Lifting the Veil.—An amusing incident occurred several years ago. An exceptional young lady, a graduate in engineering, was employed as draughtsman on the design of structures. A news reporter engaged in writing a series of articles on women in the professions called to see her and started out by asking her to state just what she was doing at the time. She replied that she was helping to design a steel structure similar to one that could be seen from the window. "Designing!" exclaimed the reporter as he looked at the several stories of open steel work. "I thought they were all alike." In great indignation the woman engineer arose like a duchess, saying, "The interview is over. With your limited education you could not possibly write an intelligent story."

It is regrettable that her impetuosity, born of loyalty to her group, spoiled a good opportunity to inform the public about the work of one branch of the engineering profession. Such knowledge is important—to the public, of course; but in how much greater measure to the engineer himself!

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CIVIL ENGINEERING

October 1942

Volume 12 Number 10

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A West Coast Cantonment

Part I. General Features of a Military City for Armored Forces

By Charles T. Leeds, M. Am. Soc. C.E.
Consulting Engineer, Los Angeles, Calif.

To completely design a small city in a period of 90 days requires coordination of a staff of experts in nearly all branches of engineering. Highways, railroads, utilities, and buildings are all designed for function. Facilities for both an armored and a triangular division were provided in the plan described by Colonel Leeds. Part II of his article will appear in a forthcoming issue.

PLANNING and construction of an army cantonment—really a small city of 25,000 to 50,000 inhabitants, with all its necessary utilities—inevitably develops various interesting engineering and construction features. This is especially true when the camp, like the one recently completed in a Western state and here described, includes both an armored division and a triangular division, with facilities for possible expansion.

As usual, plans for typical structures such as barracks, mess halls, lavatories, and chapels, were furnished by the War Department for adaptation to local conditions. This small city had to be laid out to fit the topography, and then plans made for appropriate highways, railroad, water, sewer, and electric systems as well as for the necessary warehouses, laundry, bakery, cold storage plant, and so forth.

Above all, the layout was made as flexible as possible, with ample opportunity for modification or expansion due to organizational changes that might be found necessary to meet the rapid changes of modern warfare. The wisdom of this precaution has been amply demonstrated. The plans for that portion of the cantonment originally intended for a triangular division were later changed to accommodate anti-aircraft troops, and recently have been re-planned for blocks of non-divisional troops of 1,000 men each.

All plans and specifications for this construction were finished in 90 days, ready for bids. The value of extra care in preparing complete and detailed plans and specifications was proved by the fact that the two lowest competitive bids differed from each other by less than 0.1 of 1% of the amount of the contract. The engineers' estimate was between these two bids.

Location Carefully Chosen

The cantonment is on a large, flat mesa nearly in the center of a military reservation of about 100,000 acres, which stretches some 25 miles along the sea coast. The region is of varied topography and cover, well suited for training purposes. Wells in a river valley south of the cantonment area afford an adequate water supply. The mesa area is principally aeolian dune sand, uniformly fine in texture, and highly susceptible to erosion from wind and water.

Underlying the surface soil at very shallow depths are strata of lime shale, which afforded excellent material for road base. Three excellent borrow pits were de-

One of Two 4,000,000-Gal Storage Reservoirs in the Hills Above Camp

Collection Line Between Wells and Water Treatment Plant

DUST, SUCH AS THAT RAISED BY THIS CAR, WAS AN IRRITATING CONSTRUCTION DIFFICULTY

veloped in nearby barrancas, where the shale was exposed. It was sufficiently friable to be loaded directly with steam shovels, without drilling and shooting.

Climate is mild; minimum temperatures are seldom below 30 F and maximum temperatures for most of the year are between 55 F and 75 F. From June to October fogs are frequent. The average annual rainfall is about 15 in., most of which falls between December and April. Ground moisture is excessive only when long and continuous rains saturate the soil to the impervious shale substrata. Rains of shorter duration are quickly carried away or absorbed by the sandy top soil. Conditions vary throughout the mesa. In some places there are marsh-like conditions until late in the summer, due to concentration of water in pockets in the shale substrata. Through the dry summer and fall a persistent, strong wind from the ocean makes the dust problem a serious one wherever the surface cover has been destroyed.

Only a moderate amount of over-all grading was required, principally to level the warehouse and railroad terminal area, and to fill the saucer-like depressions where marshy conditions were caused by the underlying shale strata. It was most fortunate that no more grading was needed, for in August, when construction began, the powdery soil and persistent winds made dust conditions of the worst.

HIGHWAY AND RAILROAD CONNECTIONS

Access to the camp is afforded by two principal highways. From a small town of approximately 5,000 inhabitants a few miles away, a highway leads directly to the camp and then proceeds to an interior main highway. Another road leading from the camp connects with a state secondary highway at a distance of approximately 9 miles.

A main-line railroad extends north and south along the sea coast on the westerly boundary of the reservation. This afforded the chief means of getting material to the cantonment.

The site of this cantonment is an outstanding example of the influences of geology and water. Its selection was influenced not only by the topography and soil but to an unusual degree by the water situation. The river was the only adequate source of supply, and by the law of riparian rights, water taken from it may be used only on land that is riparian to that river. That is, it must all drain back into the same stream. Accordingly, the cantonment was laid out along the ridge and on the slope towards the river. Similarly the sewage treatment plant was so located that the effluent would drain back into the valley and replenish the underground supply. By raising the ground-water elevation near the sea coast, this would tend to prevent the landward seepage of sea water, in case of heavy draft on the wells in the dry season.

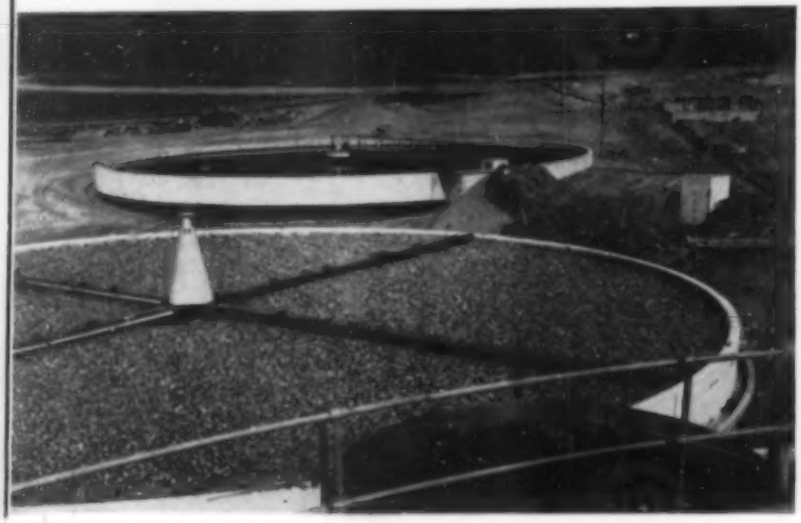
GENERAL PLAN OF THE CAMP

Although this camp was planned to accommodate two divisions and auxiliary troops, to date it contains only an armored division, hospital, warehouses, and certain supplementary troop areas. The armored division is a continuous tier of regiments following the ridge line at the southeast edge of the mesa, generally perpendicular to the prevailing wind direction, to minimize the annoyance from dust. One-half of the area contains the armored brigade and the other half the divisional troops. Between these areas is the Division Center, where the division headquarters and community buildings are located. The supplementary troops, including the Quartermaster, Ordnance, Anti-tank and C.A.S.C. organizations, are centrally located along with the warehouse area and Post Headquarters to which they are attached. North of these and more compact in shape is the area originally intended for a triangular division, but which has been recently re-planned. The hospital area is centrally located in the angle between the main troop areas, but somewhat segregated from them and on the windward side. This latter arrangement is to secure freedom from dust.

Each regiment is laid out generally according to the standard plan for armored divisions. The regimental arrangement consists of three units, the headquarters, troop housing area, and motor parks. Headquarters of each regiment is located along the main road from the entrance through the camp. The motor park of each regiment is located to the rear of, and convenient to, but on the leeward side of the housing area, from which it is separated by a firebreak.

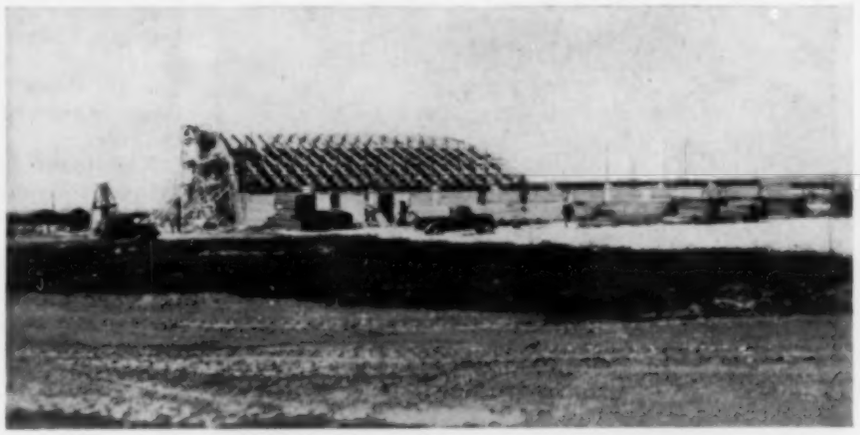
HOSPITAL FACILITIES IMPORTANT

The hospital plan conforms to the standard layout for such military structures, providing for 650 beds, with space for expansion to several times that size. The nurses' and doctors' quarters are grouped on both sides of the central administration building and face the northeast. In the center are the various wards and clinics, while the service buildings, storehouses, and barracks are located on the rear or southwest side.



BIO-FILTER AND PRIMARY SEDIMENTATION BASIN AT THE SEWAGE TREATMENT PLANT

Access to the hospital from the administration building is provided by a street which will in the course of future expansion extend to the main gate. Access to the rear or service area is by another highway. Within the group of hospital buildings there are minor access roads chiefly for the use of fire-fighting equipment. Throughout the area, spaces have been provided for nurses' and doctors' cars, administration parking, approaches to service buildings, mess halls, and so forth. Pavement in these areas consists of 6-in. shale with an armor coat of surfacing, similar to the third-class camp roads.



SPORTS AREA INCLUDES FIELD AND WOOD-FRAME BUILDING

All buildings are connected by covered walks, some open and some enclosed. It was originally contemplated that the piping for the steam distribution system would be suspended immediately under the roof of these walks. Careful study, however, demonstrated the economy and convenience, as well as improved appearance, to be achieved by putting the pipe in a concrete-lined trench directly under the walks. The space from the top of the concrete to the floor line is enclosed with drop siding and wood sheathing, and access openings are provided at suitable intervals.

Two longitudinal, concrete-paved highways form the road system of the cantonment and provide access for tanks and heavy armored traffic to the motor parks and warehouse area, while five main avenues permit egress to the training areas. Parallel to these concrete highways are two other main thoroughfares for principal traffic, with second-class pavement. There are also interior, or third-class roads to serve the housing area.

The first-class roads are of standard 9–6–9-in. concrete paving 24 ft wide, on a 6 to 8-in. shale base, with 10-ft shoulders of shale. The second-class roads have an 8-in. shale base, with 4 in. of crusher run, and 3 in. of plant mix. They are 22 ft wide with 8-ft shoulders of shale. The third-class roads are of 12-in. shale with a 1-in. armor coat of stone chips and rock. They are 16 ft wide and have 4-ft shoulders.

The main artery of the road system leads from the main entrance, southerly past the administration buildings of the post headquarters, and the armored division to the southerly end of the camp. Heavy traffic destined for the motor park will use the concrete road connecting the post headquarters with the main artery.

RAILROAD SERVICE TO WAREHOUSES

From the main-line railroad along the westerly shore of the reservation, a branch line was constructed to the cantonment. This skirts the motor park area, and provides gasoline unloading service for it. A teardrop-shaped terminal in the warehouse area facilitates the turn-around of trains and service to the various warehouses, the bakery, the ice house, and the cold-storage plant. The rails on the gasoline spur tracks are grounded as a protection against sparks. Adjoining the Y-connection with the main line are interchange tracks and at a point intermediate between the main line and the camp, for safety, is located the ammunition storage depot, served by delivery sidings. The trackage in the warehouse area is ample for the loading and unloading of troops. Altogether there are approximately 15 miles of trackage.

With a view to economy, the Quartermaster General's office directed the use of 75-lb rails and substandard roadbed dimensions for the cantonment railroad spur. The railroad company, however, declined to operate its equipment over the spur unless its own standards were maintained, and 90-lb rails were therefore used. Also, the light soil of the roadbed was so quickly eroded by wind and storm that it was necessary to maintain the standard roadbed cross section. This economy measure might be justified elsewhere, but was proved unwise in this particular case.

WATER SUPPLIED BY DEEP-WELL PUMPS

The well field which provides the water supply is in the valley about 5 miles from the camp. It is about 4 miles long, and contains a series of wells, 190 to 200 ft deep with 16-in. casing perforated with horizontal screen openings, $\frac{1}{4}$ by $1\frac{1}{2}$ in., especially suited to the sandy soil. The wells have a combined capacity of 6,300 gal per min, or 9.07 mgd. An armored division, with its mechanized units, requires a much greater water supply than other types. The maximum demand of the camp is 8,000,000 gal a day. Each well is equipped with a deep-well turbine pump, electrically controlled either at the pump or at the treatment plant. The water from the wells is pumped through a collection line to the treatment plant, whence it passes to a 1,000,000-gal pure-water reservoir, from which a booster pumping plant lifts it 600 ft through a 24-in. and 36-in. reinforced concrete transmission main to two 4,000,000-gal concrete storage reservoirs on the hills north of the camp.

This transmission main splits into two branches on passing through the camp in order to make possible a more efficient design of the distribution system. North of the camp these two mains converge again into one 36-in. line extending to the reservoirs. Five reducing valves are located along the transmission mains and the

SEWAGE TREATMENT PLANT—GRIT CHAMBER IN FOREGROUND AND TWO-STAGE DIGESTERS IN BACKGROUND

MATERIALS FOR ROADS CAME FROM NEARBY HILLS—A QUARRY SITE IN RIGHT BACKGROUND

distribution system to regulate the pressure in the lower sections of camp.

Two 1,400-gal per min and two 2,100-gal per min pumps in the booster plant lift the water the 600 ft to the storage reservoir. To protect against possible water hammer due to high head, a surge tank or pressure chamber 66 in. in diameter and 33 ft 6 in. high, designed for 275-lb pressure, is provided at the pumping plant. The storage reservoirs are of the ordinary circular, cut-and-fill type, concrete lined, with wooden roof.

WATER TREATMENT PLANT

Designed to handle 6,000,000 gal per day, the water treatment plant uses the lime-alum process and contains flash mixers, flocculators, clarifiers, filters, and recarbonation channels. Softening and filtration are necessary because the water has a hardness of 450 to 800 ppm. The plant comprises two mixing chambers 15 by 57 ft, with horizontal paddles; two sedimentation basins 70 ft square; and 12 open, downward-flow sand filters 9 ft 3 in. by 20 ft by 11 ft 2 in. deep. The wash water from the filters flows by gravity to a 35,000-gal concrete reservoir, and after settling for 30 minutes is pumped back to the mixing chamber.

Flow in the system may be briefly summarized as follows: raw water pumped from wells to treatment plant, chlorine added, flash mixers (lime and alum added), flocculators, sedimentation basins, carbonation channels (CO_2 and chlorine added), filters (chlorine added), clear-water reservoir, booster pumping plant, storage reservoirs, distribution system, camp.

SEWAGE COLLECTION AND TREATMENT

The sewage collection system is entirely gravity flow and is divided into two drainage areas—the easterly part served by a street line, and the westerly part served by another trunk line. The two lines converge into a single line leading to the treatment plant.

To meet the requirements of the State Sanitary Engineer, the two-stage bio-filtration process was adopted for sewage treatment. Also, this type of plant was cheaper to construct under local conditions than other types of equal efficiency. The first stage includes recirculation by pumps between the primary filter and the primary sedimentation basin, and the second stage includes recirculation by pumps between the secondary filter and the secondary sedimentation basin. The sludge is pumped to two-stage digesters, and the digested sludge dried on open sand drying beds. The supernatant liquor flows by gravity to the influent or to the sludge beds. Chlorine may be applied at the influent to each sedimentation basin and filter and also to the final effluent. From the treatment plant the sewage effluent flows to oxidation beds in the valley and then drains to the river.

The plant includes a Parshall measuring flume, a manually cleaned bar screen, grit chamber, two circular sedimentation tanks with sludge- and scum-removal equipment, two circular bio-filters with rotary sewage distributors, two-stage heated sludge digesters with gas holder, and duplicate chlorine dosing equipment. The control building contains a fully equipped laboratory, pumping equipment, pipe valves, and miscellaneous apparatus. All main structures are of reinforced concrete.

Sewage flow may be briefly summarized as follows: raw sewage by gravity from camp, Parshall flume, bar screen, grit chamber, primary sedimentation, primary bio-filter, secondary bio-filter, secondary sedimentation, chlorine contact basin, and final effluent through oxidation beds to river. All storm-water drainage and wash-rack water are carried directly through ditches or storm drains to the barrancas and thence to the river valley, thus replenishing the ground-water storage.

FUEL DISTRIBUTION SYSTEMS

Gas and fuel oil are used for cooking and space heating, respectively. Gas of 1,100 Btu is obtained from the

SHALE PIT NEAR THE CAMP SITE

gas company through an incoming 6-in. main. The distribution pipe system is of steel, coated with asphalt and spirally wrapped with 23½-in. asbestos pipe-line felt. The fuel oil is delivered to storage tanks by tank wagons, no pumping being required except that necessary to draw the oil from the underground tanks and deliver it to the oil burners.

The motor fuel storage and dispensing system is divided into five separate units, each independent of the other. Fuel is brought to the camp by railroad tank car. Each unit has a siding where the cars are unloaded by gravity to underground tanks adjacent to the railroad tracks. There are four 12,000-gal tanks for each of the five units, providing storage facilities for gasoline, diesel oil, and solvent as required. From these tanks the fuel is pumped through welded steel underground mains to dispensing pedestals located in the armored motor park.

The difficulties attending the organization of the construction forces and coordination of materials handling will be related in a subsequent paper.

Static Load Tests for Bearing Piles

Method for Determining Distribution of Load to the Soil in the Field

By VIGGO HANSEN *and* FRANK N. KNEAS, MEMBERS AM. SOC. C.E.

RESPECTIVELY SENIOR ENGINEER, PHILADELPHIA ELECTRIC COMPANY, AND CONSULTING ENGINEER, PHILADELPHIA, PA.

TO determine the relative movement of points in the length of a pile, a settlement compressometer was devised and used for the series of tests here described by Messrs. Hansen and Kneas. From these settlement data the load carried by each section of the pile was computed. These tests are noteworthy for their precision and also because they are the first results in this country of finding the relative displacement under loading of several sections of a pile. This paper is condensed from the original presented at a meeting of the Philadelphia Section.

THE pile foundation for the new Southwark Station of the Philadelphia Electric Company lent itself to a test of the relative load-bearing capacities of four types of piles. It was desired to find the load carried by each section of each pile from the ground surface to the tip. This could be computed from characteristics of the pile and relative displacement of the several sections. A pile-settlement compressometer was devised to make those measurements. Vertical movements of the soil surrounding the pile, and of the adjacent piles, were also measured as they indicated the effectiveness of grouping the piles. To complete the test, the piles were pulled and careful measurements taken to determine the bond between pile and soil and the elongation of the pile during pulling.

In May 1941, near the bank of the Delaware River, these tests were made on different types of Raymond, closed-end pipe, Monotube, and plain steel-H. These were driven one of each type at each corner of a 3-ft 3-in. square. The Raymond pile will be described to illustrate the procedure. It was 56 ft 5 in. long with a step-tapered shell. At the top the shell was 14 gage and $15^3/_4$ in. in diameter; at the bottom, 10 gage, $9^3/_4$ in. in diameter. The pile was driven to a depth of 53 ft 5 in. below the existing grade, passing through about 10 ft. of coarse fill, through 31 ft of river silt, and extending 12 ft into a deep bed of coarse sand and pebbles, as determined by several test borings. One boring was carried down 200 ft without encountering rock. The geological formations were identified as a Quaternary formation of the Cape May or Pennsauken type below the river silt, and below that an older Cretaceous formation known as Raritan.

STANDARD DRIVING METHOD USED

All piles were driven with a 5,000-lb single-acting steam hammer, dropping 3 ft. The Raymond shell with the necessary mandrel and the dead weight of the hammer (a total weight of 17,300 lb) forced the pile 1 ft $1^1/_2$ in. into the fill. For the next 5 ft, the average penetration was 3 in. per blow and then again the weight forced the pile down 4 ft 6 in. The next 6 ft was in the silt, where the average penetration was approximately 4 in. per blow. Below this the driving resistance gradually increased so that the penetration was only $^3/_4$ in. per blow at the bottom of the silt. In the sand and gravel 3 to 6 blows per inch were required for a distance of several feet, and the last foot required 8 to 10 blows per inch. Each one of the shells was filled with 3,000-lb ready-mixed concrete using an internal vibrator to prevent segregation, and was heavily reinforced so as to provide for pulling. The concrete in the Raymond pile was 23 days old at the time of the load test.

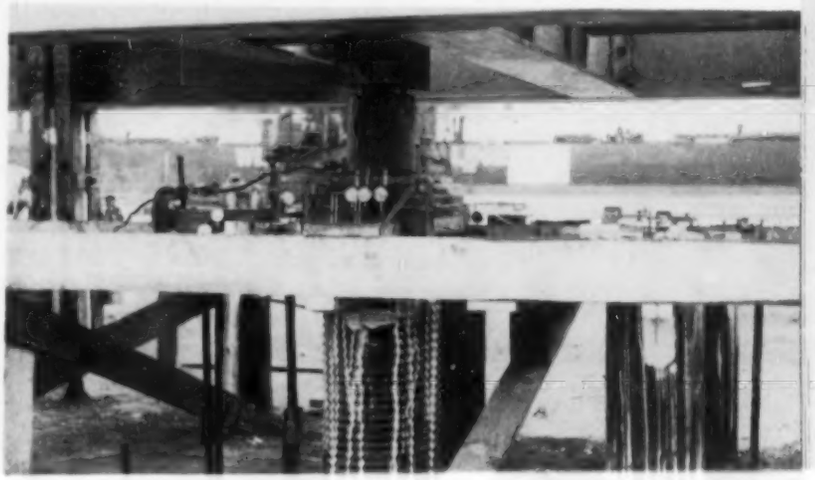
Loads were applied by a hydraulic jack, reacting against a steel beam grillage held down by four wood anchor piles at the corners of a rectangle 9 ft 9 in. by 19 ft 6 in. Pig iron piled on top of the grillage provided added resistance against uplift, as shown in a photograph. The pile compressometer devised to measure movements of the pile below the surface of the soil consisted essentially of three steel rods inserted in a closed-end tube which extended down into the pile. The tube was embedded in the concrete, and underwent compression and recovery in unison with the pile. The bottom of each rod rested on a shelf at a predetermined point within the tube, and the rod was free to move with that point. Each rod extended from the shelf up to the top of the pile, where dial gages, supported independently of the pile, measured all movements of the rods to the thousandth of an inch.

While a test was being made on any one of the four piles, other gages measured the vertical movements of the tops and bottoms of the three unloaded piles. Still other gages were set to measure vertical movements of the soil at 6 in. and at 18 in. from the outside of the pile at depths of 16 ft and 32 ft below the existing grade.

SOIL DISPLACEMENTS MEASURED

To measure these soil movements, a $^3/_4$-in. pipe was driven to the elevation desired. A $^1/_4$-in. rod within the pipe rested in the bottom of a brass cup, loosely fitted over the bottom of the pipe. Heavy oil was poured into the pipe to prevent the entrance of soil and water, and to keep the rod well lubricated. The pipe was withdrawn about 6 in., leaving the cup embedded in the soil. The rod then moved freely within the pipe, and the vertical movement of the soil in which the cup was embedded was measured by a dial gage in contact with the top end of the rod.

A load of 50 tons was applied gradually, maintained on the pile for 24 hours, and then released. Next, the load was gradually increased to 100 tons, maintained for 24 hours, and then released. On two of the piles, including the Raymond, the load was finally increased to the capacity of the jack, which was 125 tons, and maintained for a short period. Measurements were taken for each in-



FOUR PILE TYPES, WITH HYDRAULIC JACK IN PLACE READY FOR TESTING

crease and each decrease of load for each minute until the pile came to rest, and for each 1/4 hour of the 24-hour period, all movements being measured to the thousandth of an inch. Tarpaulins enclosed and protected the working space.

During the first test, wires were tried in the settlement compressometer, but on account of small kinks they did not register the movements of the lower points correctly. Rods replaced the wires in the second test and gave consistent results. During this test the pauses allowed after each increment were only 3 to 7 minutes, just long enough for the load to come to virtual rest. The measurements at the end of the pauses are the ones tabulated.

PLATFORM FOR APPLYING LOAD TO TEST PILES
Dial Gages Supported Independently on Wood Frame

A record of the settlement of the various sections of the pile as the loads were applied is given in Table I. Since the pile had been given some residual settlement by the first test, and the soil around it was somewhat compacted, the settlements during the second test were only about two-thirds as much. For example, the settlement of the top of the pile, under the first 100-ton test load, was 0.219 in., while under the second application of 100 tons, it was only 0.157 in., as given in Table I. Table II shows the recoveries as the loads were released.

TABLE I. PILE SETTLEMENTS DURING LOADING, IN INCHES

	Load on Pile, Tons				
	25	50	75	100	125
Top of pile	0.030	0.064	0.105	0.157	0.216
Point A, 16 ft 5 in. below top	0.013	0.030	0.051	0.090	0.134
Point B, 20 ft below A	0.009	0.020	0.034	0.056	0.086
Bottom 20 ft below B	0.000	0.001	0.003	0.016	0.036

TABLE II. PILE RECOVERIES DURING UNLOADING, IN INCHES

	Load on Pile, Tons				
	0	50	75	100	125
Top of pile	0.030	0.134	0.176	0.209	0.216
Point A	0.032	0.104	0.123	0.133	0.134
Point B	0.029	0.071	0.086	0.086	0.086
Bottom	0.017	0.017	0.036	0.036	0.036

The settlement of the top, bottom, and two intermediate points along the length of the pile having been found under the 100-ton load, the compressive shortening of each section was obtained by direct subtraction. Several details affected the results obtained by this procedure. A sheet of lead, 1/8 in. thick, was used to distribute the test load over the top of the pile. The measurements of the settlement of the top, taken above the lead, include about 1/64 in. of compression in the lead. Also, the effective modulus of elasticity of the pile at the laps of reinforcing bars was probably affected by the laps. It is further assumed that the modulus of the concrete of the 56-ft 5-in. long pile was larger at the bottom than at the top because of the compaction of the wet concrete by superimposed weight of concrete during placing.

After making assumptions regarding these details, we found that the average stresses in the concrete approximated 585 lb per sq in. in the top section, 430 in the middle section, and 500 in the bottom section, while the corresponding stresses in the reinforcing steel approximated 6,350, 4,300, and 5,000 lb per sq. in., respectively. Since 3 ft of the pile projected above the ground, the load on this portion was the full 100-ton test load. The computed load throughout the top section averaged 83 tons, so the load at the bottom of this section (Point A) must have been of the order of 58 tons. The average load along the middle section was found to be 46 tons, and that along the bottom section about 31 tons. These distributions are only approximate, but they indicate a rapid reduction in load toward the bottom of the pile.

TARPAULIN ENCLOSURE PROTECTS TEST SET-UP

LOAD CARRIED BY SOIL SURROUNDING SHAFT

Analysis of the stress and load in the pile indicates that about two-thirds of the load was carried by friction, or bond, between the pile and the soil surrounding the upper part of the shaft, and that only one-third was carried by the pile where it entered the gravel. From the pulling tests, which will be noted later, it was found that the bond between the pile and the surrounding soil reached 865 lb per sq ft. Using this bond stress to measure the load delivered to the surrounding soil by each section, it was found that about 62 tons were carried into the soil around the shaft above the gravel, and that 38 tons were carried into the gravel. When the shoulders forming the step-tapered pile shell are considered as providing direct bearing, it seems evident that more than the 62 tons must have been carried into the soil above the gravel.

Results of the two sets of computations—one based on the compressive shortening in the pile and the other on the bond between pile and soil—checked one another satisfactorily. It is noteworthy to find that so large a percentage of the load was transferred by the shaft into the surrounding soil, when it was only fill and river silt. This bond was also shown when withdrawing the driving rod at the time of making core borings. A dynamometer was inserted in the pulling cable, and the pull required showed an average of about 800 lb per sq ft of bond between the soil and the rod.

Before the actual foundation piles were driven, all the fill above the silt was removed and the piles were driven through the silt into the gravel. During this driving, it was found that the piles would frequently settle 10 to 15 ft from only the dead weight of the core and hammer. Even so, as was shown by further tests on those piles, much of the load was transmitted into the silt through bond around the shaft.

RELATIVE MOTION OF SOIL AND PILES

Measurements were taken of the vertical movements of the soil surrounding the shaft of the Raymond test pile. A ratio between the movements of the soil and the movements of the pile was found. Under test loads as large as 50 tons, as shown by average readings 6 in. and 18 in. away, opposite Point A on the pile, the soil moved downward only about 40% as much as the pile, while at the lower level, Point B, the soil moved down about 70% as much.

When the test load was increased to 100 tons, the soil opposite Point A moved downward only 30% as much as the pile, and that opposite Point B, 60% as much. In both cases the soil at the greater depth moved more nearly in unison with the pile. Near the bottom, the soil and the pile probably moved in almost complete unison. When the load was removed from the pile, the surrounding soil at each point returned to about its original position.

When any one of the group of four test piles was being tested, measurements were taken of the movements of the bottoms of the adjacent unloaded piles. The Monotube pile was on the corner of the square, diagonally opposite to the Raymond, and its bottom was higher than that of the Raymond. The bottom of this pile moved very little in response to the movement of the Raymond. The bottom of the pipe pile, and of the steel H-pile, which were at the adjoining corners of the square, and more nearly on a level with the Raymond, settled about one-third as much as the bottom of the Raymond. Under its test load of 125 tons, the bottom of the Raymond settled 0.036 in. and recovered to 0.017; at the same time, the bottom of the H-pile settled 0.010 in. and recovered to 0.002; the pipe settled 0.012 in. and recovered to 0.002. This seems to indicate that the load on the Raymond pile forced a saucer-like depression in the gravel, which dragged down the bottom of the adjacent piles. This depression largely disappeared on removal of load, and the bottoms of the adjacent piles returned to almost their original levels. The settlement of the top of each adjacent pile was only about one-tenth as much as the settlement of the top of the Raymond.

WATER TANK PROVED EASY TO HANDLE AS LOAD FOR TEST PILE

As generally recognized, the allowable load on each pile in a group is less than the allowable load on an isolated pile. This is also indicated by the tests at Southwark, where some of the load was transferred from the loaded pile to the adjacent piles or to the soil under them. What percentage of reduction of allowable load should be made for each pile in a group is a question for seasoned judgment. Much depends on the spacing of the piles in the group, and also on the spacing of the groups themselves.

Probably the most satisfactory check on the carrying capacity of a group is to compute the load caused by that group on the underlying bearing stratum. The bed of gravel at the bottom of the piles at Southwark is estimated, from the borings, to have a capacity of 5 to 6 tons per sq ft. When it is recognized that the forces radiating from the bottom of the pile during driving compact this gravel, the 6-ton limit is probably not too high.

For piles spaced 3 ft 3 in. on centers, we have an area of over 10 sq ft per pile. On that assumption, the gravel would carry safely loads of 60 tons for each pile in a group.

At the completion of the load tests, each of the piles was pulled by jacking upward from the steel grillage, heavy reinforcing having been cast in the piles to permit this operation. When a 60-ton pull was reached, the top of the Raymond pile had moved upwards $^1/_8$ in., while no movement was registered at the bottom of the pile. At 70 tons the bottom started to move. The average friction on the shaft at this pull reached 750 lb per sq ft. At 80 tons, the top was up $^1/_4$ in. and the bottom was up $^1/_8$ in., the pile showing again a stretch of $^1/_8$ in. The average friction on the shaft at this pull reached 865 lb per sq ft.

It is possible that if the pull had been kept constant at 80 tons, the pile would have kept on moving upwards at a very slow rate. In order to get the pile out of the ground without too much loss of time, however, the load was run up beyond the calibrated limit of the jack, to an estimated pull of 135 tons. By the time this load was first reached, the stretch in the pile, due to the increased tension, was about $^5/_{16}$ in. The 135-ton load was applied and released a number of times so as gradually to work the pile out of the soil, but there was no perceptible drop in the required pull until after the pile had moved up several inches, after which this pull slowly dropped to about 45 tons.

Only 100 tons at the maximum was required to pull the pipe pile. Even at this pull, the stretch in the pile was only $^1/_{16}$ in. This can be accounted for very readily, because in addition to the reinforcing, which was the same as in the Raymond pile, there was about 12 sq in. of steel in the pipe cross section. Stretch during pulling was not increased for the H-pile or for the monotube.

TEST RESULTS SUMMARIZED

The outstanding accomplishment of these tests was the accurate measurement of the amount of settlement that occurred at the bottom and intermediate points of each of the piles. The ratio between the settlement of the top and that of the bottom varied for different loads on the same pile, and also for the same load on different types of piles. The amount of relative motion that occurred between the pile and the surrounding soil was measured at different depths, and under different loads. Compressive shortening in different sections of the length of the pile was measured, and thus the unit stresses, and the loads carried by each section, could be approximated with some certainty.

The rebound of the bottom of the pile and of intermediate points was measured, as well as that of the top, showing how much of the rebound of the top was due to recovery in length of the pile, and how much to the rebound of the soil under the pile.

Some indication was obtained as to the reduction in allowable load that should be made for piles in groups as compared with an individual pile, by measuring the movements of the tops and bottoms of adjacent unloaded piles.

FILLING PILE SHELLS WITH CONCRETE
Shells at Left Are Stacked Ready for Driving

New Gaging Station for Mountain Streams

Forest Service Installation Combines a San Dimas Flume with Two Broad-Crested Weirs

By H. G. WILM

SILVICULTURIST, U.S. DEPARTMENT OF AGRICULTURE, FORT COLLINS, COLO.

ONE of the many duties of the Forest Service of the U.S. Department of Agriculture is the investigation of watershed management. A phase of this subject is the measurement of the flow of mountain streams, which varies through a wide range. To measure and record these varying quantities, a type of gaging station which combines a flume and two broad-crested weirs has been developed at the Rocky Mountain Forest and Range Experiment Station at Fort Collins, Colo. Mr. Wilm discusses the accuracy with which extremes of flow in flashy mountain streams may be measured by this type of installation.

AS a part of its investigations in watershed management, the Forest Service is having to make accurate measurement of the flow of mountain streams, usually small in size, but subject to wide ranges of flow. On many streams ordinary stream-gaging stations, sharp-edged weirs, or flumes have not proved satisfactory because of the influence of unstable stream beds and moving bed-loads on the relation of discharge to depth.

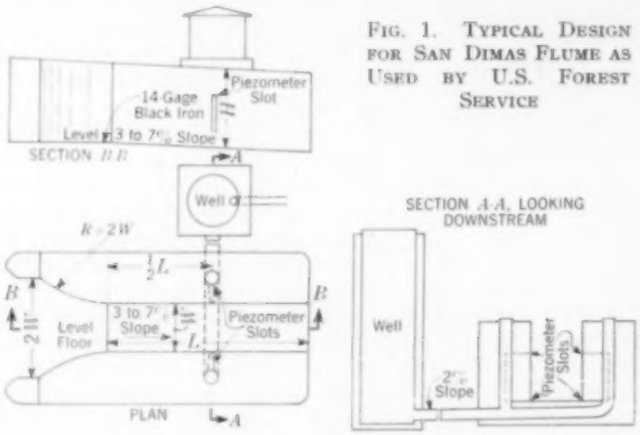


FIG. 1. TYPICAL DESIGN FOR SAN DIMAS FLUME AS USED BY U.S. FOREST SERVICE

Experience in measuring mountain streams for experimental purposes has shown that the following requirements must be met by any gaging station designed for this purpose:

1. Adaptability to a wide range in flow. Protracted ground-water flow should be measured within a range of 5% above or below the true discharge. At the same time the station must be capable of handling with reasonable accuracy, peak discharges up to several hundred times the ordinary minimum.

2. Stable and easily determined "rating" characteristics. The cross-section should be simple and regular, to facilitate calibration in field or laboratory.

3. Relatively high flow velocities in the measuring section. Velocities must be high enough so that any debris or bed-load reaching the station is carried through the measuring section rapidly and without deposition.

A stream-gaging station designed to meet these requirements is now in operation in the Manitou Experimental Forest in Colorado. The measuring section for normal flow consists of a 2-ft wide San Dimas flume made of reinforced concrete, with a floor of 14-gage iron to minimize erosion by bed-load material and to insure a stable friction factor for the flume. Placed on bedrock in the stream channel, this flume collects and measures discharges ranging from 0.75 to 30.0 cu ft per sec.

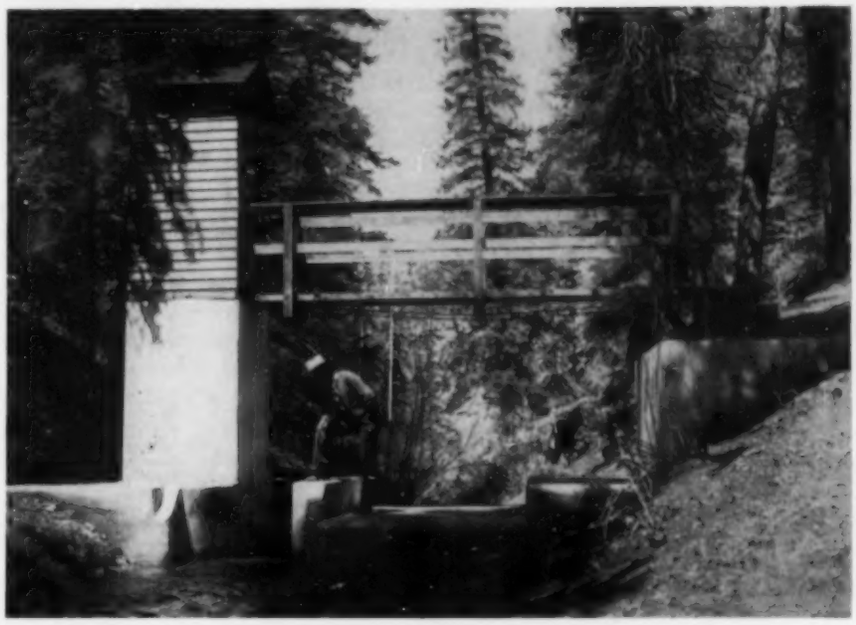
SUPERCRITICAL VELOCITIES WITHIN THE FLUME

In principle the flume resembles a broad-crested weir, with pressure measurements taken at the longitudinal midpoint of the weir (Fig. 1). To obviate the removal of contractions by silting, the ordinary bottom contraction is entirely replaced by a cylindrical transition of 4-ft radius, as shown in an accompanying photograph. Approaching this channel constriction the stream, if flowing rapidly, passes through a hydraulic jump and enters the transition at a velocity below the "critical." Then, leaving the transition and entering a rectangular channel set at a grade of 5%, the flow drops through Belanger's "critical" depth and proceeds through the flume at a shooting velocity.

The width and depth of the San Dimas flume are designed for accurate measurement of the normal range

GAGING STATION IN MANITOU EXPERIMENTAL FOREST, COLORADO, FROM DOWNSTREAM
Normal Flow Measured in 2-Ft Flume, Peak Discharges Over One or Both of Adjacent Broad-Crested Weirs

of stream flow, which prevails perhaps 90% of the time. Excessive rates, which occur rarely and need not be measured with great accuracy, are handled by broad-crested weirs adjacent to the flume. One of these, 6 ft wide and 1 ft deep, is placed at an elevation of 2 ft above the flume floor, with a wall separating it from the flume. After water depths in the pool upstream of the structure exceed 2 ft (about 1.18 ft in the flume at the piezometers), flow is measured in both flume and weir, a single depth being recorded in the stilling well. A second weir, simply a broad step at a higher elevation, is designed to handle the possible maximum flood—about 600 cu ft per sec in the station illustrated. These weirs must of course be calibrated in the field. Discharges for the whole structure are rated for depths in the single stilling well.



GAGING STATION FROM UPSTREAM
Cylindrical Flume Transition Appears at Left

Since March 1940, when this gaging station was installed, the recorded stream flow has not been great enough to permit complete calibration of the broadcrested-weirs. Some discharges have been measured through the lower weir, however, and ample data have been obtained for the flume to bear out the results of laboratory model tests and to demonstrate the accuracy with which discharges may be computed from recorded water depths.

CLOSE COMPARISON OF RATING FORMULAS

Field rating data for the flume have agreed very closely with figures obtained by extrapolation of model results. A "field" formula for the flume, $Q = 13.95\ H^{1.276}$, was derived by fitting a logarithmic straight line by "least squares" to 10 measurements of depth and discharge obtained in July 1940. Subsequently 12 other measurements were made over a period of about 21 months. The measured discharges were compared with values computed from the original least-squares formula. All field measurements were made by means of a velocity-head rod operated by several different observers. The model formula, $Q = 14.20\ H^{1.28}$, was computed from laboratory observations of depth and discharge obtained in 1937 on a one-quarter scale model of the San Dimas flume. In both these formulas Q = discharge in cu ft per sec, and H = depth in ft, measured in the stilling well.

Considering the long period of time over which the field data were taken, these figures conform with pleasing accuracy to both field and model formulas. The model formula appears high; still, the greatest deviation of field discharges from this formula was under 4½%. As compared to the field formula, 11 observed discharges fell below, and 11 above, the computed values, and the greatest deviation of observed from computed values was 4.27%. A new rating formula, $Q = 13.953\ H^{1.276}$, fitted to all 22 points, conforms almost exactly to the original field formula. The standard error of estimate for the new formula is ±2.00%, and the correlation coefficient is +0.9999. These results seem to indicate quite conclusively that the San Dimas flume, as installed in this station, is satisfactorily accurate and stable in its discharge characteristics over a considerable range in both time and rate of flow.

Sufficient data have been obtained on discharges over the 6-ft broad-crested weir to demonstrate the approximate relation of discharges through the flume and weir to depths measured in the single well. To fit the observed values, a rating formula was prepared by the method of least squares. This formula is $Q = 9.7035\ H^{2.9477}$, in which Q is the discharge for the flume and the weir together, and H is the depth of water in the flume. The errors of these discharges are somewhat greater than those of the flume alone (standard error of estimate = ±4.56%), largely, it is believed, because of small variations in depth of water in the flume corresponding to a given depth on the weir. Such variations are to be expected and the resulting errors in discharge are a necessary sacrifice, offset by the need for only a single record of water depths. To obtain more precise data on depths and discharges over the weir, a second recorder and piezometer well would be required. At this particular station the additional precision is unnecessary, since up to August 1942, flow had passed over the broad-crested weir during only 2 of the 28 months that the station had been in operation.

VIEW OF FLUME FROM ABOVE
Note Smooth Sloping Floor and 4-Ft Entrance Width, Twice That of Flume Proper

Highway Transport in Wartime

By H. S. FAIRBANK

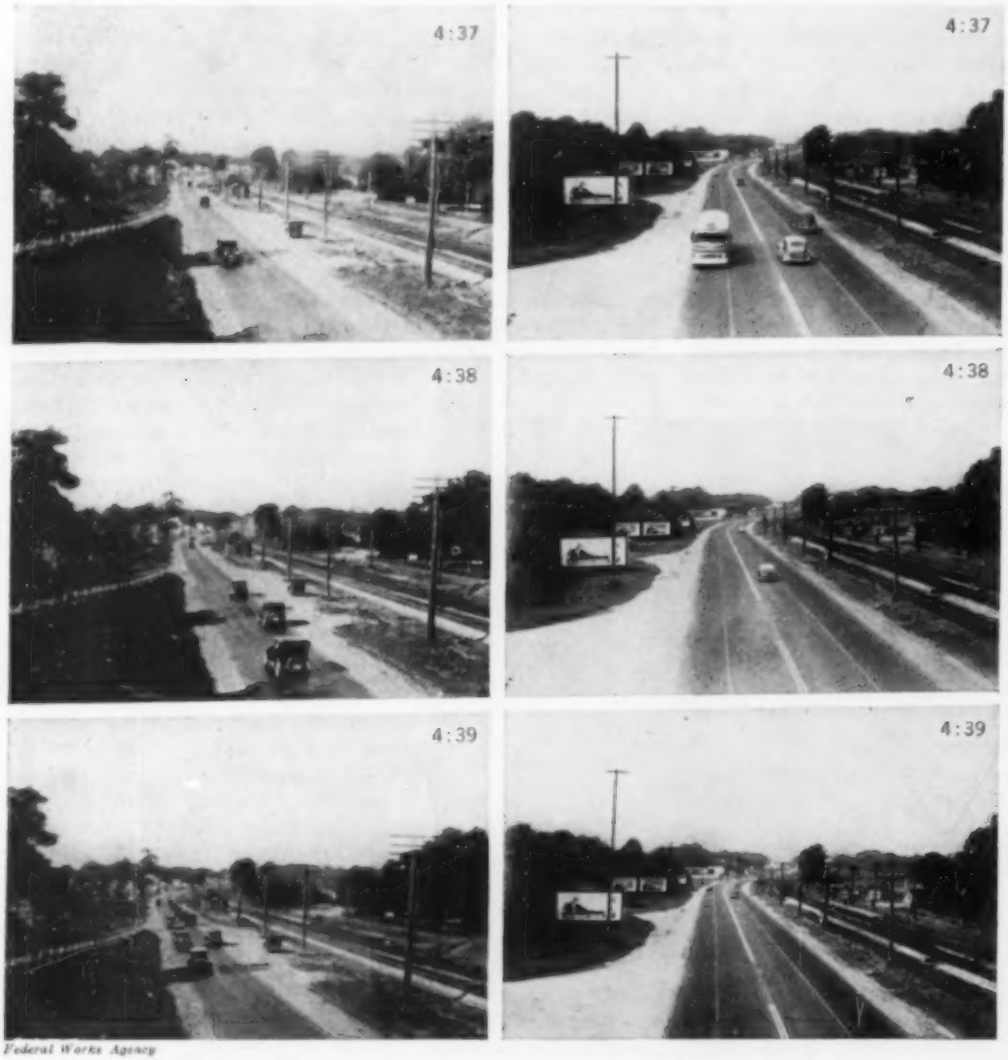
CHIEF, DIVISION OF RESEARCH, PLANNING AND INFORMATION, PUBLIC ROADS ADMINISTRATION, FEDERAL WORKS AGENCY, WASHINGTON, D.C.

MOTORISTS as well as manufactures are acutely aware that war is upsetting their normal use of the highways. Researches and traffic counts here quoted indicate what has happened, what steps have been and should be taken, and what the future portends. Cooperation in reducing unnecessary highway use and in broadening truck limitations is essential. Fortunately the required solutions are known; unfortunately they have not yet been wholly adopted. This valuable summary of present status and trends has been revised and brought up to date following its original presentation before the Society's Roanoke Meeting.

PEACETIME preconceptions of the character of highway transport in time of total war are undergoing amazing alterations. To a people provided with three fourths of the entire world's supply of motor vehicles, sharp curtailment of that facility was well nigh unthinkable.

That certain adjustments would be essential could be foreseen—a substantial decrease in recreational use and an offsetting increase in business use; definite priorities of sanction or service; and a certain amount of diversion of vehicle manufacturing capacity from civilian to military production. As long as a year ago these changes were not beyond the bounds of reasonable expectation.

But that the great automotive industry would suddenly be brought to a complete halt in its production of vehicles for civilian use; that pneumatic tires, the very sine qua non of motor vehicle transportation, would be denied to the average vehicle owner so quickly and so completely—these developments certainly were beyond the range of normal foresight until the early morning of last December 7.



Federal Works Agency

JULY 4, 1927 JULY 4, 1942

TRAFFIC CHANGES IN 15 YEARS—PICTORIAL RECORD AT SAME POINT ON U.S. 1, BELTSVILLE, MD. Same Day of Year, Same Time of Day, Count Showed 23% Less in 1942 Than in 1927

Before the cowardly attack on Pearl Harbor, the expected problems of highway transportation were mainly those concerned with the avoidance of congestion on somewhat inadequate highways, in use by an intensified traffic of unprecedented volume. Since that event we have had to recognize that the most careful husbanding of narrowly limited vehicle resources will be the first and most vital necessity.

SIGNIFICANT TRAFFIC CHANGES

Permanent automatic traffic counters installed on the roads throughout the country recorded in every month of 1941 traffic substantially greater than in the same months of the previous year. The December 1941 traffic, 12.5% heavier than in the preceding December, represented about the average increase of total 1941 traffic over 1940.

But beginning December 11, three days after the declaration of war against Japan, various restrictions on the sales of vehicles and tires were successively adopted with significant traffic results. January traffic was only 1.1%

above the previous year, and that of February averaged 7.6% less. In March and April gasoline deliveries to the Atlantic States were cut, first by 20% and later by 33⅓%, but the April automatic recorder counts showed traffic reductions little greater in these states than in the nation as a whole. For the entire country, the April reduction was 15.8%; the Middle Atlantic States dropped only 16.8%; and only in the South Atlantic States, down by 21.4%, was there any marked evidence of a possible effect of the cut in gasoline supply. Vehicle operators everywhere were showing a willingness to reduce voluntarily the amount of their driving by almost as much as the 20% required by the initial cut in gasoline supply in the Atlantic States.

After May 15, however, this condition was changed sharply. The 50% gasoline supply cut and card rationing which then became effective in the East produced a marked change in the traffic volumes recorded in the rationed area. For the last two weeks of May the counters recorded traffic 45% below that of the same period of 1941, whereas in the unrationed area the traffic dropped by only 16.9%.

CITY TRAFFIC ALSO AFFECTED

The automatic counters reflect with substantial accuracy what is happening to ordinary rural traffic, but do not indicate the trends of urban traffic. There is some evidence that urban traffic has been reduced much more in the rationed area than in the unrationed. Over the Hudson River crossings at New York, traffic in the latter half of May was down approximately 30% below that of the corresponding period in 1941. The San Francisco bridges, in sharp contrast, reported in May a combined traffic increase of 8%. Yet in the same month California's rural traffic decreased more than 27%.

A somewhat clearer indication of the change in the rationed area is given by an analysis of the results from automatic recorders in Connecticut. On "recreational routes" traffic declined 53% in the first four weeks of June below the volume for the same period in 1941. On "through routes" the corresponding decline is reported as 49%; on "local roads" it was 36%; and on "suburban routes," only 29%. These figures compare with an average decline, for all rural roads, of 42% in the same period.

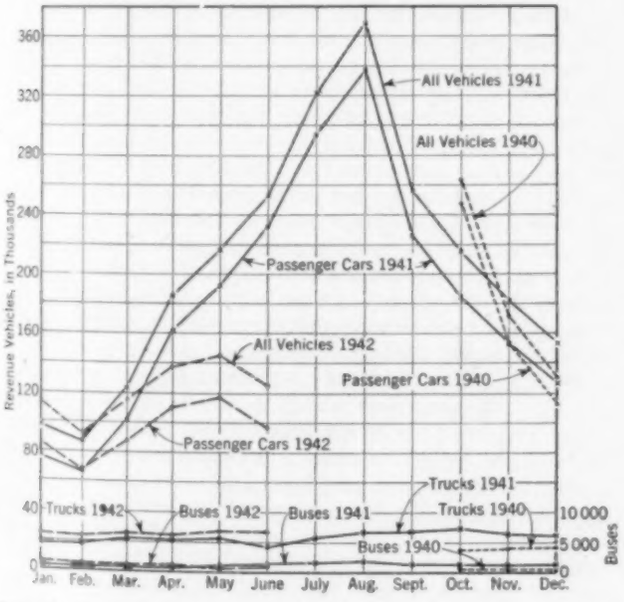


FIG. 1. PENNSYLVANIA TURNPIKE TRAFFIC, OCTOBER 1940 TO JUNE 1942

It is the general observation also that passenger-car traffic is declining more sharply than that of trucks and busses. This conclusion is supported by reports of the Pennsylvania Turnpike Commission (Fig. 1).

RECREATIONAL TRAVEL SQUEEZED OUT

These scattered indices suggest that the restrictive measures are having the effect that might be considered

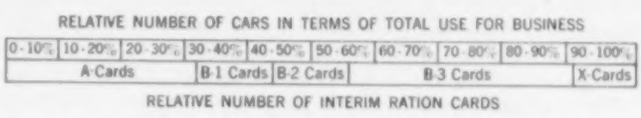

RELATIVE NUMBER OF CARS IN TERMS OF TOTAL USE FOR BUSINESS
0-10% 10-20% 20-30% 30-40% 40-50% 50-60% 60-70% 70-80% 80-90% 90-100%
A-Cards
B-1 Cards
B-2 Cards
B-3 Cards
X-Cards
RELATIVE NUMBER OF INTERIM RATION CARDS

FIG. 2. GRAPHIC ANALYSIS OF ALL PASSENGER CARS IN RATIONED SEABOARD AREA
Use for Business Purposes vs. Gasoline Ration Cards

most likely—the squeezing out of the customary recreational uses of passenger cars.

In the Atlantic Seaboard area subject to gasoline rationing, the planning surveys showed that 60.5% of all normal travel by passenger cars was for business purposes, 15.5% for social purposes, and 24.0% for recreation. As the average total travel within the states concerned was found to be 8,612 miles, the average mileage required for business purposes was approximately 5,200.

It is interesting to compare this estimated normal business mileage with the average rate of 5,050 miles annually permitted by the interim-plan ration cards (Table I).

TABLE I. DATA ON INTERIM-PLAN GASOLINE RATION CARDS OF VARIOUS DENOMINATIONS ISSUED, AND AVERAGE ANNUAL MILEAGE (AT 15 MILES PER GAL. OF GASOLINE)

STATE	% OF RATION CARDS OF VARIOUS TYPES					TOTAL NO. OF CARDS	AVE. ANNUAL MILEAGE PERMITTED
	A	B-1	B-2	B-3	X		
Me.	29.1	9.9	11.2	38.4	11.4	156,005	5,152
N.H.	34.1	10.6	11.1	34.0	10.2	95,010	4,891
Vt.	31.8	10.5	11.5	34.2	12.0	76,633	5,047
Mass.	25.1	9.3	11.2	43.6	10.8	750,851	5,304
Conn.	33.3	12.9	13.9	32.0	7.9	388,739	4,737
R.I.	27.5	11.8	12.5	41.3	6.9	150,943	4,981
N.Y.	30.0	7.7	10.0	43.3	9.0	1,644,405	5,104
N.J.	30.3	9.8	10.8	41.6	7.5	891,443	4,969
Penn.	29.3	10.0	10.7	41.8	8.2	985,865	5,031
Del.	31.2	10.5	11.6	39.5	7.2	58,086	4,892
Md.	23.4	8.0	10.0	46.8	11.8	394,518	5,461
D.C.	24.7	10.2	14.9	38.6	11.6	137,170	5,272
W.Va.	36.9	12.0	11.8	30.2	9.1	20,095	4,692
Va.	27.8	11.0	11.9	41.5	7.8	425,737	5,032
N.C.	32.6	11.6	11.5	34.6	9.7	496,830	4,900
S.C.	33.6	10.2	10.7	36.0	9.5	249,618	4,902
Ga.	32.7	10.5	11.0	37.3	8.5	392,660	4,889
Fla.	31.4	9.2	9.0	39.2	11.2	340,172	5,104
Average	29.6	9.7	11.1	40.6	9.0	7,654,780	5,050

In computing the annual mileage rates shown in this table, the value of the ration card unit was taken at 3 gal and the mileage per gallon at 15. On these assumptions the A-card permitted travel at the annual rate of 2,340 miles; the B-1 card, 3,660 miles; the B-2 card, 4,842 miles; the B-3 card, 6,318 miles; and the X card, which was unlimited, was conservatively assumed at 10,000 miles.

Road-use studies of 12 representative states in the rationed area permitted a breakdown into percentages of the total number of passenger-car owners performing various percentages of their total travel for business purposes, as follows:

PASSENGER-CAR OWNERS	BUSINESS TRAVEL	PASSENGER-CAR OWNERS	BUSINESS TRAVEL
9.3%	0–10%	10.8%	50–60%
7.9%	10–20%	10.4%	60–70%
8.9%	20–30%	10.5%	70–80%
9.9%	30–40%	10.1%	80–90%
10.3%	40–50%	11.9%	90–100%

Although, for various reasons, a direct comparison of this classification with Table I cannot be made with entire propriety, such a comparison is nevertheless shown in Fig. 2. This graph tends to indicate that the ration cards were issued in excessive numbers in the A and B-3 classes, and possibly in deficient numbers in the B-1, B-2 and X classes.

The principal difficulty encountered in the interim rationing period was due to the fact that ration cards were apparently issued for a mileage in excess of that obtainable with the quantity of gasoline actually for sale. Compare the figure of 4,306 miles (a cut of 50% in the normal annual 8,612 miles) with the 5,050 miles permitted by the ration cards at 15 miles per gal. This defect has been corrected by the coupon rationing plan now in effect. This plan contemplates that holders of ration books will be able henceforth to obtain the full amount of gas provided by their stock of coupons at the currently fixed value.

RATIONING VS. VOLUNTARY TRAVEL REDUCTION

Clearly what has already occurred in the rationed area is the squeezing out of substantially all of the more frivolous passenger-car use. The more universal necessity of rubber conservation may eventually require a somewhat similar sacrifice the country over. Whatever may be the possibilities of synthetic rubber production, the necessity for a conservative use of tires will remain. Whether this will be done by means of universal gasoline rationing or, outside of the presently rationed area at least, by a sufficient voluntary reduction in car use, will depend largely upon the success of the campaign for voluntary reduction now being waged throughout the country.

Launched in May, this campaign appears now to be making substantial progress toward its goal. The plan calls first for a radical staggering of school, business, and mercantile hours, and the shifting of hours of industry, to spread traffic peaks and enable mass carriers to handle as much as possible of the daily traffic flow. Next—and this is where the plan will meet its crucial test—it seeks to reduce the remaining passenger-car movement by inducing industrial and office workers to share the use of fewer cars, and by discouraging all unnecessary car use. Failure will mean only that the same result must be obtained by compulsion; and this should insure a reasonable final success for the voluntary plan.

How great is the need for such conservative measures, whether voluntary or enforced, is shown by the results of tire-condition surveys. At four West Virginia industrial war plants, it appears that 30 to 60% of the tires now on the workers' cars will be completely worn out within the next six months. At one plant 80% of the present vehicles will be off the road by reason of tire wear within a year.

Continued use of these cars is a vital necessity. Substitute mass transportation is already taxed to capacity, and voluntary car sharing has already raised the normal car occupancy of less than two persons to a minimum of 2.6 persons at one plant, a maximum of 4.2 at another, and an even 3 persons at the other two plants.

A recent survey canvassed the managements of 1,250 manufacturing corporations engaged in producing war materials, all located in Michigan. Replies from 749 (Table II) show clearly how dependent are these vital industries on highway freight transportation. Furthermore, 75% of the 434,684 employees of these plants were found to be coming to work in automobiles carrying less than two persons per car.

COMMUTERS PARK CARS AT SUBURBAN TROLLEY TERMINUS INSTEAD OF INCREASING CONGESTION ON WASHINGTON, D.C., STREETS

Public Roads Administration

U.S. Army Signal Corps

MILITARY MOVEMENTS SHOW MINIMUM CONFLICT WITH CIVIL TRAFFIC THANKS TO OFFICIAL COOPERATION AND ADVANCE PLANNING

TABLE II. HIGHWAY FREIGHT TRANSPORT SERVICE FOR 749 MICHIGAN FIRMS

Incoming Freight			Outgoing Freight		
No. of Plants Concerned	% of Total Plants	% of Materials by Truck	No. of Plants Concerned	% of Total Plants	% of Materials by Truck
520	70	50	561	76	50
281	38	90	316	43	90
100	13	100	112	15	100

HIGHWAY IMPROVEMENTS HELP

In many cases the dependence of industry upon highway transportation, particularly for the daily home-to-work travel of its employees, is due to the fact that new or greatly enlarged plants are located beyond reach of any adequate mass transportation facility. An airplane factory near a large Eastern city is a case in point. Rapid expansion has now more than tripled its pre-war employment. A year ago workers, drawn mainly from the nearby city crowded the narrow access roads. A main railway line has never been able to handle the daily influx. A few months ago, when the employees totaled approximately 30,000, just 350 were conveyed to work by bus; most of the rest came in private automobiles occupied by an average of 2.85 persons per car.

By vigorous effort this situation is now greatly improved. Several new access roads of greatly enlarged capacity have been or are being built, all financed largely with federal funds. Seventy-five hundred workers, about a sixth of the present employees, are being transported in approximately 100 buses, many converted from sightseeing use. A far greater number still come in automobiles, but the number per car has been increased to a present average of 4.4. As a result about 8,700 cars now convey to and from work more workers than were formerly moved in 12,000 cars.

Often, as in this case, new war plants or military establishments occupy locations not even served by a main highway. Local roads have to serve a daily flood of thousands of vehicles in place of hundreds or only scores as formerly.

But it is being realized more and more that if existing and even enlarged capacities of access streets and highways are to afford adequate wartime service, prompt measures must be taken to transfer to mass carriers as much as possible of the worker travel, and to reduce the number of passengers per car.

Public Roads Administration

THIS EXPERIMENTAL ODT COMBINATION IS LONGER THAN LAW ALLOWS IN MANY STATES

INTERSTATE TRAFFIC LIMITATIONS

Except in special areas, the war has not thus far developed the greatly increased traffic volumes on main rural highways that, but for various restrictive measures, would probably have been generated. Movements of military vehicles form an increasing element of the traffic on such main routes. Thanks to the efficient and helpful cooperation of officials, these movements are normally made with a minimum of interference with civilian traffic.

In many instances it is necessary to move over the highways for long distances vehicles or loads not permitted by existing state laws. In dimensions or weight, some of these movements tax highway capacities, and must be specially routed. Examples are the planned regular movement of Ford bomber parts from the factory to distant plants for assembly. Too bulky and light for efficient rail handling, these will be moved in especially designed vehicles exceeding in length and width the regulation limits of most of the states en route. Another case is the recent movement of an experimental passenger-carrying trailer, whose 45-ft length also exceeded state limitations.

Application to state officials for special permits always involves some difficulty. Much of this would be avoided if all states would agree to a "floor" of weight and size limits substantially above the lowest now in force, to be applicable without special permit for the duration of the war. Such an agreement reached within the past year by the New England and Middle Atlantic states I recommended for general adoption at the Society's Roanoke Meeting. Later Commissioner of Public Roads MacDonald endorsed it. Subsequently, the Governors of all the states were asked, through the Council of State Governments, to proclaim the adoption of complete license reciprocity, with suggested "floor" limits of size and weight as wartime policy.

Unfortunately this appeal has met with far from universal approval. In 19 states one or more statutory limits lower than those proposed are still enforced unless special permits are obtained. It appears that only by the issuance of a Presidential Executive Order will it be possible to achieve a more complete accord. This latter method, proposed by the American Association of State Highway Officials, has recently received the favorable vote of 47 of the 48 state highway departments.

If adopted, these limits would permit vehicles having the following characteristics:

Width	96 in.	Axle load	18,000 lb
Height	12½ ft	Gross load:	
Single length	35 ft	2-axle	30,000 lb
Combination length	45 ft	3-axle	40,000 lb
Weight per in. of tire width	600 lb	Semi-trailer	40,000 lb
		Other combinations	40,000 lb

Against the day when an emergency may require quick marshaling of available truck and bus resources for public or military service, an inventory of such vehicles has been taken in all states. Conducted by means of a questionnaire, the effort met with a remarkable voluntary response from approximately 90% of the vehicle owners. The results are now being tabulated. These summaries will afford information as to the number and character of the vehicles of each class available for use in any area. The state files, similarly classified, will facilitate communication with the vehicle owners in case of need.

In further preparation for a possible emergency, other measures are desirable, particularly in areas subject to direct enemy action. Among these are the selection of alternate routes supplementary to the principal routes over which traffic may be instantly diverted according to a prearranged plan, the planning of separate routes for civil and military traffic in emergencies, and other similar measures. Such planning requires the advance preparation of maps and orders ready for instant publication and execution, and calls for the cooperation of state and city highway and police authorities with Civilian Defense and military representatives in each area.

Pioneer work of this nature has been done by the New York Metropolitan Defense Transport Committee, and similar undertakings wherever necessary will shortly be launched at the combined initiative of the Office of Civilian Defense and the Highway Traffic Advisory Committee to the War Department, with the aid of the Public Roads Administration. It is highly important that adequate plans of this sort be prepared and proved in practice tests in order that highway transport may not fail to meet the most crucial of wartime tests if it should come.

Efforts described here have been initiated and presented by many public agencies. Credit is due to the Public Roads Administration, the Statewide Highway Planning Surveys, the Highway Traffic Advisory Committee to the War Department, the West Virginia State Road Commission, the Michigan State Highway Department, and the Work Projects Administration.

Public Roads Administration

LINE OF APPLICANTS FOR GAS-RATIONING CARDS WAS SEVERAL BLOCKS LONG IN WASHINGTON, D.C.

Control Surveys for Military Mapping

U.S. Coast and Geodetic Survey Speeds the Establishment of Important Reference Network

By C. L. Garner, M. Am. Soc. C.E.

Captain and Chief, Division of Geodesy, U.S. Coast and Geodetic Survey, Washington, D.C.

SUCCESSFUL execution of a military mission depends upon careful preparation for any turn of events. Though at present we are not threatened with invasion, prudence directs collection of all information that would be essential to the successful repulse of such forces. Military mapping has now been extended to areas only partly covered previously. Hard pressed to keep the control surveys ahead of the mapping crews, the U.S. Coast and Geodetic Survey has had to plan its work carefully so that limited crews could cover the many districts as climate permitted. This paper was originally presented by Captain Garner before the Surveying and Mapping Division at the Society's Roanoke Meeting.

As recently as a year ago, the War Department was planning the development and completion of strategic maps covering important coastal and border areas of the country. Four federal agencies agreed to cooperate in the program, which was put into effect in December 1941. Since that time the Coast and Geodetic Survey has worked closely with the War Department both in mapping and in the extension of the necessary triangulation and level control.

Experience indicated quite definitely that an increased demand for mapping and control would accompany the approach of the scene of conflict to our shores. Requests for control data, mostly from military sources, have increased enormously during the past three years, and to meet emergency requirements the Survey has taken advantage of every opportunity presented to build up its organization to the limit of its resources.

Exposed Triangulation Station
Shifting Sand Dunes Occasionally Destroy Monuments in This Area

The needs so far exceeded the resources for accomplishing the field work that it became necessary for the Survey to establish a policy of priority in the selection of areas. The policy adopted was designed to meet the needs of the military establishments for war mapping or other defense projects in so far as possible. Therefore, upon adoption of the four-agency program, the Survey was in a position to enter into the work immediately and for more than a year its work has been limited almost entirely to projects desired by the military establishments.

The Corps of Engineers has been most cooperative, for without the funds which it has transferred to the Survey for projects in Alaska and the United States, it would have been impossible for the Bureau to maintain its organization of trained technical personnel.

It is regrettable that it takes a crisis to bring us face to face with conditions that need remedying. Since control is a prerequisite for mapping, it should be established in advance in all regions so that the data will be available whenever actual mapping operations are undertaken. Only rarely has it been possible to do this. As with the war mapping, the control has frequently been called for at about the same time as the mapping itself, and obviously this prevents the orderly and systematic procedure necessary to efficient operation. Should large-scale mapping of any of several fairly large areas, in which triangulation monuments have not yet been established, be called for next month or even next year, one can well understand that it might be impossible to furnish the necessary control in a short period of time.

Upon acceptance of the program in December, field parties already organized were immediately dispatched to the priority areas in North Carolina, Virginia, and Maryland, and in January to California, to push the control during the winter. An unusually favorable winter season permitted very good progress and the projects in Maryland, Virginia, and California have already been completed. The parties there, together with additional ones, moved north to take up work in Pennsylvania, New York, New Jersey, northern California, and Washington for the spring and summer.

The control for this work was necessarily designed to meet all requirements for topography, whether by ground methods or by photogrammetry. Along the coast the control stations had to serve for hydrographic and coastal defense surveys. Only by such thorough coordination of surveys is maximum usefulness obtained.

Triangulation Network Extended

The determination of latitudes and longitudes for large numbers of marked points on the ground is generally accomplished by the process of triangulation, which has the almost unique virtue of checking itself as the work proceeds. Of course the initial determination of latitude and longitude must be obtained from astronomical observations. Theoretically, there would seem to be even greater possibilities than have already been developed in this method of locating objects from instrumental observations made at two or more known points. When it comes to the practical application of the work, however, there are a

Early Earthenware Monument Recovered in Maryland
Such Urns Were Frequently Used 75 to 80 Years Ago

large number of variables—disturbing factors such as haze, fog, wind, and smoke—all of which often have a very serious effect on the actual field operations of triangulation. Also, the curvature of the earth must be considered and the instruments must of course be elevated above trees, surrounding buildings, or other obstructions.

The process of triangulation may be applied also to moving objects, such as the determination of position and elevation of balloons and aircraft, but in this case the problem is subject to all the variable elements just mentioned, as well as to the difficulty of synchronizing the observations from all the stations. In this discussion we are dealing only with the horizontal and vertical control so necessary to the proper coordination of mapping projects, so that they may eventually form a complete topographic map of the country, without gaps or overlaps.

The North American Datum was adopted by the United States, Canada, and Mexico as the basis for the computation of the triangulation in North America. It was derived only after extensive circuits of triangulation had been carried over the United States and considerable areas in Canada and Mexico. This framework was composed of first-order triangulation. Generally arcs of first-order triangulation have been run at intervals of about 100 miles in the United States. These are interspersed by second-order arcs, which fill in the spaces between the first-order arcs.

Briefly, the specifications for first-order triangulation require that base lines be measured with an accuracy which allows a probable error no greater than 1:1,000,000, and an agreement between bases, as carried through the triangulation, of 1:25,000 or better. The astronomical azimuths which control the orientation of the triangulation are determined with a probable error not exceeding 0.3 sec of arc. The average triangle closure must not exceed 1 sec and the maximum closure should not exceed 3 sec. On second-order work, the agreement between bases as carried through the triangulation must be 1:10,000 or better, and the average triangle closure should not exceed about 1.5 sec, and the maximum closure, 5 sec.

TRIANGULATION OBJECTIVE
Electric Signal Lamp Directed Toward Observer

Sometimes questions arise with regard to the accuracy of the triangulation between bases; that is, it may be desired to know the accuracy of the length of any line of the triangulation. The probable error for a length of line anywhere along a scheme of triangulation can be computed, but it will have no more value than a circuit closure itself, since the limiting errors in the observations of angles, due to all sources including the variables of weather, are not readily adaptable to mathematical treatment. Furthermore, the cost of computing the probable errors in all lines would be excessive. The preponderance of loop closures of 1:75,000 or better is convincing proof of the accuracy of the triangulation. It should be borne in mind that the limiting closure of 1:25,000 represents the maximum permissible error.

ADJUSTABLE THEODOLITE TRIBACH
Convenient for Mounting Directly Over an Old Station

Air photographs are now used for practically all sizable mapping projects. The accuracy of mapping based on air photographs is largely dependent on the control indentifiable on the photographs. With adequate control, both horizontal and vertical, the detail from the photograph may be transferred by multiple projectors or other instruments to the map itself with accuracy. Control must be three-dimensional, with latitudes, longitudes, and elevations.

MONUMENTS SERVE MANY USES

All horizontal and vertical control should be laid out to best serve its many uses in mapping, whether by ground or photogrammetric methods, and for general surveying and engineering purposes. In the selection and marking of triangulation stations and bench marks, it is necessary to place them where they will be of the greatest use and convenience to the engineering and surveying public.

Triangulation stations must be durable and therefore should be in areas least subject to disturbance. They should be marked by inscribed tablets to inform the public what they are. They must, as far as possible, be accessible for general use, and should be near some identifiable objects to which reference can be made in the descriptions. Objects such as road intersections, houses, and isolated trees serve well. Each triangulation station should have two reference marks which can be used to relocate it if it is disturbed. There should also be an azimuth mark, at least a quarter of a mile distant, to which the direction has been determined.

Each triangulation station should have a subsurface mark to serve if the surface mark is disturbed. All marks to be used as magnetic stations should be free of reinforcing material. Bench marks must be durable, accessible, and near objects which can be used for referencing. They should be set to avoid disturbance by frost action and should contain inscribed tablets similar to those previously mentioned for triangulation stations.

Finally, the public must be kept aware of the value of the stations and bench marks, and how they may be used. Even though the control network is far from complete, there are now about 100,000 triangulation stations and 200,000 bench marks in the United States. Public consideration is the only possible way of properly maintaining these markers. All are urged to help preserve the stations and to send information regarding any changes in the markings or their surroundings to the U.S. Coast and Geodetic Survey.

Light-Reflecting Concrete for Factory Floors

White Cement Surface Increases Efficiency of Illumination

By M. A. Berns, Assoc. M. Am. Soc. C.E.
Universal Atlas Cement Company, New York, N.Y.

TO increase illumination in factories and other buildings, it long has been the practice to treat walls and ceilings in light colors so that they will absorb less of the light and reflect and diffuse more of it. But in general the use of floors as giant reflectors started only when the critical need for light on the under side of huge wings and fuselages in war-constructed aircraft assembly plants forced their consideration. From the cost studies here reported by Mr. Berns it is evident that such floors are suitable for a great variety of uses by engineers.

GOOD illumination is important in any building, and especially in factories for war production. Studies over many years show that good illumination increases speed and ease of seeing, resulting in reduced eye strain, headaches, and absenteeism. With proper light, the quality and quantity of production are increased, and accidents, errors, spoilage of materials, damage to products, and shutdown of machines are substantially reduced. Experience shows that with better illumination, a factory's output rises, rejects drop, accounting and drafting room workers perform more efficiently, and more goods are sold.

Light-reflecting floors of white cement were installed in assembly plants built in 1941 for Boeing, Consolidated, Douglas, and North American. They and others are installing similar floors in additional plants this year.

PLACING WHITE CONCRETE

The procedure is to place the white cement concrete as a topping on a gray concrete subbase. White or light-colored sand and stone are used as aggregates, and care is exercised to keep any discoloring materials out of and off of the top course. A separate mixer, carefully marked, is used for the white cement mix. Special placing equipment is also employed, and separate tools are used to avoid any contamination or discoloration of the white surface.

View Showing Contrast Between White and Gray Floor Concrete

Survey Showed That Surface at Left Reflected 61% More Light Than One at Right

Nominally the mix is 1:1:2, with not more than 5 gal of water per sack of cement. After placing, the topping is rolled or tamped to compact it thoroughly and to secure bond with the base course. Troweling is delayed until the concrete has set enough to prevent bringing an excess of fine material to the surface. A stainless metal or celluloid trowel is used.

The finished floor is covered with strong, durable, non-staining, waterproof paper overlapped and sealed with latex cement or similar non-staining material. The paper is kept covered with clean dry sand or boards. After thorough curing and cleaning, the surface is sealed with a colorless, non-staining material to preserve the original whiteness.

CASE HISTORY OF WHITE AND GRAY FLOORS

In a plant of the Consolidated Aircraft Corporation, built and designed by the Austin Company, a combination of circumstances provided data for an unusual case study. In this plant the receiving area and the assembly area adjoin each other. One has a gray cement concrete floor and the other a white cement concrete floor separated only by an expansion joint, as shown in a photograph. Lighting facilities in each area are identical. A scientific survey consisting of over 300 light measurements was made by the General Electric Company in these two areas. In addition, the plant engineer made a survey when the floors were new and again after six months. These data show that:

1. The white cement floor reflects 61% more light than the adjoining gray floor.
2. This increase in reflection increases the illumination on the vertical plane 20.6%.
3. After six months of use the white cement floor retained more of its original reflection value than the gray cement floor.

The plant is lighted with two-lamp RF-type fluorescent units in porcelain-enamel reflectors mounted 40 ft high. Nominal spacing averages 8 ft 4 in. along the truss

To Avoid Discoloration of White Concrete a Separate Mixer Is Used for It

and 12 ft 6 in. lengthwise (twin units on 25-ft centers). Wall and ceiling surfaces are covered with fiber glass for air and sound conditioning. The average illumination level in service, as calculated for the area when empty, was 36.5 ft-c. A survey made when the lamps had burned an average of over 1,500 hours showed an average of 36.3 ft-c, very close to the calculated value.

Included in the investigation were measurements of the reflection factor in the two areas. This factor may be defined as the ratio of the light reflected by a surface to the light incident upon that surface. Measurements made over the gray cement floor showed a reflection factor of 27.4%, while the white cement floor reflected 44.0%.

These figures show that the white cement floor in this plant is a 61% better reflector than the adjoining gray concrete. In other words, 61% less light is absorbed by the white than by the adjoining gray floor. This means that to place this much light under the wings and fuselage of a bomber on the gray floor would require 61% more light than the present system provides.

LIGHT-REFLECTING FLOOR IN ASSEMBLY PLANT REDUCES HEAVY SHADOWS AND ELIMINATES NEED FOR PORTABLE SPOT LIGHTS

VERTICAL ILLUMINATION ALSO INCREASED

The white cement floor also increased the vertical illumination. This is a measure both of the direct light and of the reflected light on a vertical plane. In the plant referred to, the lighting survey showed the average vertical footcandles to be 17.45 over the gray cement floor and 21.05 over the white cement floor, an increase of 20.6%. This represents a substantial improvement in lighting intensity—of value in any plant.

Considering these data on a dollars-and-cents basis, what would be the direct cost of the white cement floor compared with that of the additional lighting facilities required to obtain the same level of vertical illumination with gray concrete?

Fluorescent lighting fixtures (as used in this plant) are designed to operate at a given wattage. Hence, to increase the wattage—to produce 20.6% more light on a vertical plane—it would be necessary to increase the number or the size of the fixtures in ratio to the additional wattage desired. In either case, costs are comparable. In the area having the white cement floor there are 6,720 two-tube fixtures at $33 net each. If the number rather than the size of the fixtures were increased, the extra cost would be $45,683.

In this installation each fixture has two tubes at $1.80 net. Their rated life is 3,000 hours. Accordingly, on a 24-hour basis, these lamps have an approximate life of 4 months and thus require about three new lamps a year. Thus the annual cost for additional lamps to achieve the same vertical illumination over the gray floor as is obtained over the white floor would be $14,950.

As the number of lamps is increased, consumption of electricity increases. In the lighting system in this plant the power consumption is 200 w per fixture, at an esti-

STRIKING OFF FINISH BEFORE ROLLING OR TAMPING OPERATION

CARE IS EXERCISED IN PLACING WHITE TOPPING OVER GRAY SUBBASE TO PREVENT DISCOLORATION

mated cost of $\frac{1}{2}$ cent per kwhr. Operating on a basis of 12 months per year and 730 hours per month, the extra cost for power would be $12,127.

Adding these three figures together, it is seen that to obtain the same vertical illumination over the gray floor as is obtained over the white one would require a total outlay of $72,760 the first year. Since the extra cost of the white floor was estimated at $40,000, a total of $32,760 was saved by installing it instead of providing extra lighting. Annual savings after the first year ap-

TIME-SAVING ROTARY TROWEL USED FOR PRELIMINARY FINISHING

proximate $25,000 for electricity and lamp maintenance. If the comparison were made with a darker floor than provided by the gray cement, the saving would be correspondingly larger.

It should be emphasized that these figures apply only to this particular installation. Costs elsewhere might be higher or lower depending upon the size of the plant, the lighting installation, and the relative reflection factors of the white cement floor as compared with some other darker type. Also the cost of a white cement floor is subject to variation depending upon wage rates, availability and cost of light-colored sand and stone, and the cost of white cement.

The purpose of the foregoing study is not to suggest the installation of a white cement floor rather than the installation of additional lighting facilities. Lighting standards throughout industry in general are low, and efficient operation calls for much higher levels of illumination. In achieving these higher levels, white cement floors should be considered a valuable supplement to, not a substitute for, the installation of adequate lighting facilities.

The plant previously discussed also serves to illustrate how air-conditioning costs may be reduced. In the area with the white cement floor the connected kilowatts total 6,720 fixtures multiplied by 200 w per fixture, divided by 1,000, or 1,344 kw. A 20.6% increase in lighting facilities to provide the same level of illumination over the gray cement floor would require an increase of 20.6% multiplied by 1,344, or 277 kw. Most of this additional energy would appear as heat. Each additional $3\frac{1}{2}$ kw requires an extra ton of air conditioning at an average cost of $250 per ton. In this particular instance, this amounts to approximately $17,000 for installation. In addition there would be an estimated saving of $3,500 per year in operating cost for electricity.

The saving in operating cost is definite. The saving in installation cost might not be achieved fully in practice because it may not be possible to design an air-conditioning system within such a close tolerance. But in any event the possible savings should be taken into consideration when designing the air-conditioning system as well as the lighting system.

SAVING OF CRITICAL MATERIALS

In any large installation, the wiring and distribution system often is a bottleneck for any large increase in load. To have added 277 kw to the lighting load also might have required an increase in system capacity. This involves the use of heavier copper in the wiring system, and of larger distribution transformers, switchgear, cable, cutouts, and lightning arresters as well as lighting fixtures and lamps. These items use large quantities of critical materials such as copper, rubber, steel, magnesium, zinc, lead, aluminum, and resins, most of which today are obtainable only on priorities. Compared with this, white or light-colored sand and stone and white cement are non-priority materials. Thus the use of these floors will save valuable materials for war needs.

MAINTENANCE OF WHITE CEMENT FLOORS

To maintain the maximum illumination it is necessary to keep the lamps, fixtures, ceilings, and walls clean. The same is true of light-reflecting floors. They must be properly maintained so as to absorb as little light as possible.

While a white cement floor naturally shows the dirt more than a dark floor, Consolidated's plant engineer reports that it is no harder to maintain. His standard procedure is to sweep the floor daily, damp mop it once a month, and scrub it with a rotary brush machine every two or three months. He reports further that the white floor promotes cleanliness—that the men working on it try to keep it clean.

Light measurements were made by the plant engineer when the floor was new and again six months later "when the lamps were ready for renewal and the floor was as dirty as it was expected to get." These measurements showed that it retained more of its reflecting value than the gray floor. When new, the latter reflected 27.4% of 36.3 ft-c, or 9.9 ft-c. In comparison, the white cement floor reflected 44% of 36.3 ft-c, or 16.0 ft-c. After six months' operation the gray floor lost 22% of its value, leaving 7.7 ft-c. Under the same conditions the white floor lost 18%, leaving 13.1 ft-c. In other words, when new the white cement floor reflected 61% more light than the gray floor, and after six months of use it reflected 70% more. The plant engineer sums up the matter as follows:

"The white cement floor was put in with the idea that good enough illumination would be thereby obtained for men working partially under the wings of the planes and at other similar locations. It seems adequately justified

FINAL HAND FINISHING WITH STAINLESS TROWELS REDUCES TENDENCY TO SPOT

by good seeing ability at all locations and the almost complete absence of shadows."

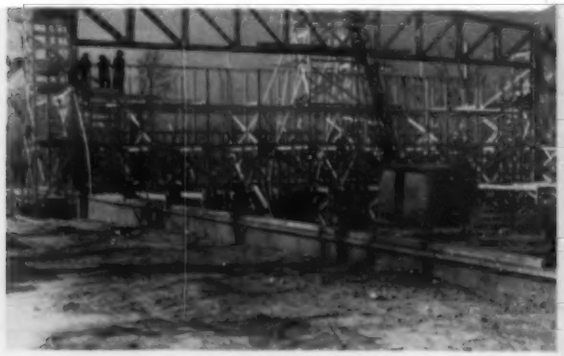
The foregoing cost studies are on the basis of a 20.6% increase in illumination on a vertical plane and thus are applicable in principle to almost any plant or other building. The indicated savings are in addition to the value of the 61% increase in reflection value on the under side of wings and fuselage, which is critical in an aircraft assembly plant, and in other plants where work on undersides and on vertical faces is performed.

In preparing this article use has been made of material from bulletins of the Illuminating Engineering Society.

Timber Structures

Savings in Material and Wider Uses Made Possible by Recently Developed Procedures

By LAURENCE P. KEITH, ASSOC. M. AM. SOC. C.E.
STRUCTURAL ENGINEER, TIMBER ENGINEERING COMPANY, CHICAGO, ILL.



RING CONNECTOR TRUSS OF 75-FT SPAN FOR CANTONMENT THEATER

TEN years of progress in the art of using timber structurally accounts for the major part of its contribution to the war program today. True, without such progress lumber would have been a factor just as it was in World War I. But if limited to the construction possibilities of that age, wood could have released only a fraction of the steel which it is freeing today for uses where no substitutes will serve. This paper was originally presented before the Structural Division at the Annual Convention of the Society in Minneapolis, Minn.

FORTUNATELY great progress in the rational use of timber had been accomplished before "defense" construction started. Engineering design data resulting from experimentation and research were available; machines, patterns, and dies were already producing commercially the necessary items so that there was no retooling lag; and economic worth had been established through actual large-scale use by industries and government agencies in both the United States and Canada. The depression compelled the lumber industry to initiate and sponsor new ideas and methods. Subsequent developments, whose merits have come to be realized, are responsible for the role timber is now playing.

There are numerous reasons for this progress but some are more spectacular than others. The most important is reduction in the time required for construction. The old rod-and-block type of truss was tedious to put together compared with today's timber truss. Completion in 34 days after letting of the contract for a frame warehouse 100 by 320 ft, with 50-ft trusses, is one record. Completion in 60 days of a frame building occupying an area of 356,000 sq ft and requiring twenty-eight

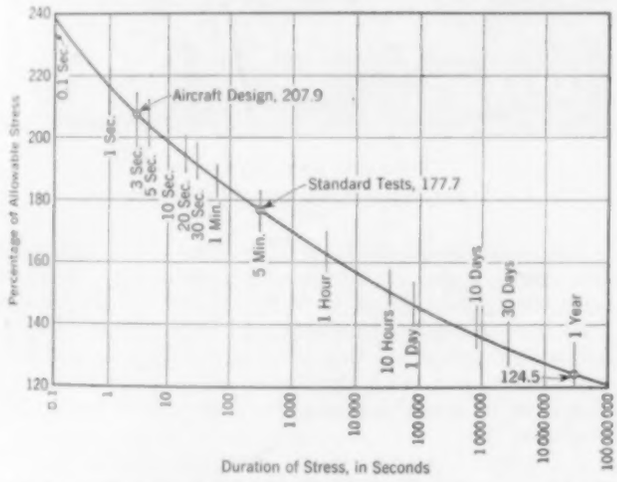


FIG. 1. TEST RESULTS ON THE RELATIONSHIP BETWEEN DURATION OF LOADING AND STRENGTH OF WOOD IN BENDING

140-ft trusses, each designed to carry 180 tons, and a like number of 100-ft trusses, is another record. Such speeds could not have been achieved with the older style of truss except with excessively large labor crews not available today.

Prefabrication is the second most important reason. It is difficult even for one closely connected with the timber program to realize the extent of this advance. In one section of the country 1,000,000 fbm of lumber is being fabricated into trusses and columns every 24 hours, seven days a week. Plants have assembly lines where each operation is completed with almost lightning rapidity by the use of drills running at 3,400 rpm. At one plant a count showed that three connector grooves were being cut by one cutter head in one second. Elsewhere in the country another half million feet is being prefabricated daily. These quantities do not include those for trusses and columns built on the site, either by special companies or by general contractors. Formerly roof trusses of the rod-and-block type were seldom preframed and even when they were their joint details did not permit the application of the rapid assembly-line methods used today. Frequently these prefabricated items are shipped, knocked down, across the continent.

SIZE OF STRUCTURES NOT LIMITED

The third reason for the great advances in the use of timber is the removal of limitations on size. Apparently there is no limit to the magnitude of the structures that can be built of timber today. In 1941 a Mid-West aircraft factory was attracting attention because of trusses of 140-ft span spaced 53 ft on centers. Later glued laminated wood arches of 152-ft span, spaced 10 ft on centers, for two hangars, brought forth favorable comment. In June 1942, plans were prepared for a single building to be roofed with 5,000 trusses of 25-ft span, 700 of 75-ft span, and 120 of 150-ft span with four monorails on the lower chords, each adding a load of 5,000 lb. This is rather bewildering, but it is not the largest of several similar projects. And all these are dwarfed by the plans for a timber building 100 ft high and 1,000 ft long, having trusses with a clear span of 250 ft.

In these three directions—speed of construction, prefabrication, and size—there has been definite progress in the structural use of timber. Moreover, the principal developments have made possible the use of smaller sizes such as would be available from local stands of timber. This is important because even in the off year of 1938 only nine states—Rhode Island the most eastern and Nevada the most western—produced negligible amounts of timber (Lumber Distribution and Consumption for 1938, U.S. Forest Service). New England is today producing 2,750,000 fbm of lumber daily. If the transportation system becomes congested, this local availability of timber may be part of the answer to the building problem. It could not be entirely solved by turning to concrete because forms would be needed, and frequently they require almost as much lumber as if the structure were built of wood in the first place.

GLUED LAMINATED ARCHES FOR A COLLEGE FIELD HOUSE
Halves of the Arch Are Raised and Spliced at Center of 120-Ft Span

Glued laminated wood construction for beams, columns, and arches is one of the principal recent developments. No metal is required and lumber which otherwise might be structurally useless can be employed advantageously. In the parts of the beam or arch where the stresses are light, low-grade material can be employed. The lumber must be dry, but seasoned 1-in. boards, used largely for this construction, are usually obtainable locally. This type of construction has a great future because very fine architectural effects can be secured. The authoritative publication on this subject is "The Glued Laminated Wooden Arch," Technical Bulletin No. 691, by T. R. C. Wilson, Senior Engineer, U.S. Forest Products Laboratory.

LAMINATED RIBS

Glued laminated construction has been used for many years in the upper chords of timber bowstring trusses. Laminations of either 2 by 3 in. or 2 by 4 in. are customary practice. Frequently engineers unfamiliar with the behavior of timber analyze the stresses due to bending of the upper chords just as they would for other materials. Initial stresses so calculated may be higher than the allowable unit stress, but in wood these initial stresses are dissipated. The exact reason why the stresses computed by the customary formulas do not actually materialize in the wood member is not fully understood. Relief from these internal stresses apparently occurs very soon after bending because tests made soon after gluing showed that it had already taken place. Mr. Wilson's bulletin provides a formula for arriving at the proper reduction for this factor. Applied to a bowstring truss of even the sharp curvature formed by a 16-ft radius, the allowable working stress in bending need be reduced only about 3%.

Composite timber-concrete deck construction is another forward step in the structural use of timber. The slab system, permitting continuity, was developed by the Service Bureau of the American Wood-Preservers' Association, and the T-beam type, without continuity, by the Oregon Highway Commission. The treated timber base of the slab type is composed of 2-in. planks from 2 to 12 in. in depth, laid on edge with alternate planks raised to provide grooves. The superimposed concrete slab is bonded to this timber base by triangular metal-plate "shear developers." The entire dead load must be carried by the timber section but the composite section acts for live load, so that at the mid-spans tension is resisted by the wood and compression by the concrete. Where the moment is negative, compression is resisted by the wood and tension by the reinforcing steel. Form lumber is eliminated; a relatively small amount of metal is required; and if continuity is discarded, then the reinforcing steel for tension over supports is not needed. The result is a deck adequate for heavy loads and possessing a hard wearing surface.

The third development is the modern timber connector system of construction. Its first use to any extent was in Europe after World War I, when it was found to be an answer to a large rehabilitation program coping with shortages of materials and of man power. The system was sponsored and developed in this country by the lumber industry after the depression as a means of making the use of lumber more economical. The U.S. Forest Products Laboratory has made some 18,000 strength tests which have been utilized by the lumber industry in recommending working loads for the connectors.

Basically, metal ring connectors, concentric on a bolt, magnify the area for transferring loads many times that available from a bolt without connectors. One pound of metal so used with wood in trusses takes the place of 11 to 12 lb of structural steel. Connections or joints of trusses are provided by lapping the pieces, which are often relatively wide in comparison with their thickness. As for the sizes used, 2-in., 3-in., and 4-in. joists and planks predominate.

Metal-ring connector construction has introduced two new features in timber trusses—tension web members of wood, and "spaced" columns. Because of these features, the most economical type of older-style trusses may not be the most efficient in connector construction.

CRANE BAY IN A LAYOUT SHOP
Lower Side Spans Carry a 10-Ton Crane

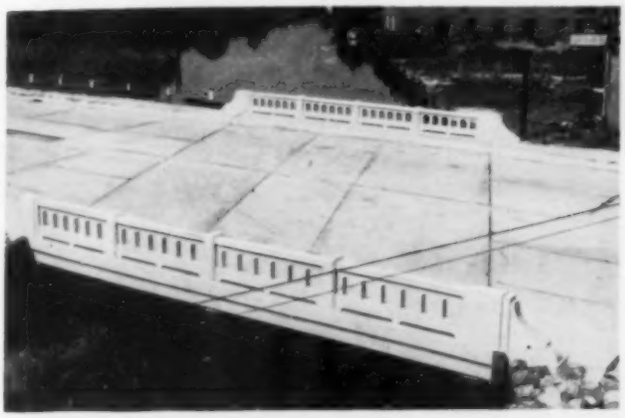
The rod-and-block type of timber truss invariably used steel rods for tension web members. Wood is very strong in tension with the grain, but an efficient joint connection was necessary to develop this strength. Connectors provided this, and such things as steel rods and heel plates were eliminated from wood trusses by this type of construction even before there was a steel shortage.

A "spaced" column is one composed of two or more individual members with their longitudinal axes parallel and the pieces separated at the ends and approximate midpoint of their length by blocking, the end blocks being joined to the members with connectors which introduce end restraint, thereby increasing the load capacity of long columns. At an L/d ratio of 50, with the connectors placed from $L/10$ to $L/20$ from the column end, the unit compressive stress parallel to the grain is three times that for a simple column. When the distance is $L/20$ from the column end, the increase is $2^1/_2$ times. These increases hold for the larger L/d values until the column enters the intermediate class, and from there the advantage gradually decreases to zero when an L/d of 10, or the ratio of a short column, is reached.

Another advantage is a limiting L/d ratio of 80 instead of 50 as recommended for a simple column. In connector construction the upper chords are usually designed as spaced columns. Web compression members, when composed of two pieces, are also designed as spaced columns. Either the web or the chord members, depending on details of design, usually serve the dual purpose of member and end block for the spaced column of the other member. Mid-length blocking and bolting must be provided in every case.

GRAIN OF WOOD CONSIDERED

Design of a connector joint is quite similar to that of a riveted steel joint once the allowable load is ascertained. In selecting this value, however, a number of factors must be considered. Standard and minimum allowable spacings between connectors transmitting load parallel with the grain of the wood differ from those transmitting load perpendicular to the grain. The capacity varies from that for standard spacing to that for the minimum allowable spacing. There are also standard and minimum allowable end-distances and edge-distances, with a specified reduction of values, when there is a departure from the standard. Design loads for connectors are of maximum amounts when the load is transferred parallel to the grain of the wood, and decrease in a straight-line ratio as this transfer becomes perpendicular with the grain. Another variation in value occurs where the connectors are in opposite faces instead of in one face only. Still another variation is controlled by the thickness of the lumber. Different types of connectors have different values and these also vary as the connectors are used in the different species of timber. The design values are taken directly from tables based principally on research at the U.S. Forest Products Laboratory. Arrangement of groups of connectors in a joint sometimes requires ingenuity in design but skill comes with experience. Eccentricity should be shunned, and force lines should meet at a point.



TWO-SPAN COMPOSITE TIMBER-CONCRETE BRIDGE AT SALISBURY, MD.
43-Ft Structure on Skew, Has 56-Ft Roadway

Flat Pratt or flat Howe trusses are most economically designed when all the web members are placed between the members composing the chords. In this case the tension members are usually composed of two pieces and the compression members are single pieces placed in center position from front to back. Such an arrangement avoids transferring the load at right angles to the grain of the wood where the connector capacity is a minimum. This economy does not materialize in a triangular truss; therefore in this case the compression members are usually placed between chords and the tension members outside.

Very little dry lumber of structural size is available under present conditions but detailing can care for shrinkage. Wood does not shrink appreciably endwise, so the distance from center to center of joints of connector trusses remains practically constant. Planks 4 in. and less in thickness ordinarily season without developing objectionable characteristics. Occasionally the end will check along the center of a relatively wide face. In such cases two rows of connectors are usually required, so a saw kerf can be cut along the center of the piece and terminated beyond the last connector in a $\frac{1}{2}$-in. hole. Cover and splice plates retard drying of the main members which they connect and season more quickly than those members. Hence when two rows of connectors are involved, two pieces, each half the face width, can be used. In all types of bolted construction, with or without connectors, it is good practice to tighten the nuts after the trusses have been in place for a time.

During the war emergency, structural designs should for the most part be based on the use of the lower stress-grade material because logs which would normally produce the higher stress-grade lumber are now being cut for special uses such as aircraft, pontoons, and ships. The use of the lower stress-grade lumber is actually advantageous in long compression members because in these the load capacity is determined solely by the modulus of elasticity, which is the same for all grades.

Saving materials by increasing allowable working stresses is common practice today. Usually this is done at the expense of the factor of safety, but in timber design these stresses may be increased without any reduction in the factor of safety by taking advantage of increased load capacity when timber is subjected to shorter-than-permanent loadings.

DURATION OF STRESS

Effect of duration of stress on wood was discussed by J. A. Newlin, M. Am. Soc. C.E., Principal Engineer (now Specialist, Mechanics of Wood), U.S. Forest Products Laboratory ("Unit Stresses in Timber," TRANSACTIONS of the Society, Vol. 91, 1927, p. 400). The chart there given as Fig. 3 for the relationship between the mechanical property of Sitka spruce and the duration of stress has also appeared in a number of publications of the Forest Products Laboratory. Based on test results, this chart shows that a safe static load of one year would be only 70% of that which would cause failure when applied for five minutes. Working stresses for timber have been derived in part, and in addition to a factor of safety, by taking the ultimate strength values

COMPLETE BENT IS RAISED INTO PLACE IN TWO-BAY MANUFACTURING PLANT

OREGON HIGHWAY BRIDGE OF 132-FT SPAN
Treated Timber Carries an Asphaltic Concrete Wearing Surface

from tests in which the load is applied for approximately five minutes and to these values applying a factor of 9/16 for conversion to a safe value for permanent loading.

The above-mentioned duration-of-stress chart can be made more in accord with customary design concepts if the values are converted from the 5-min loading basis to a permanent loading by multiplying by the reciprocal of 9/16, or 1.777. (See Fig. 1.) This makes the application of the chart more practical, since all our working stresses for timber are on a permanent basis. With this method, it is apparent that shorter-than-permanent loads permit increased working stresses.

Advantage is taken of the relation between duration of stress and load in the design of airplanes. In "Aircraft Woods: Their Properties, Selection and Characteristics" (Reprint from National Advisory Committee for Aeronautics Report 354, in October 1941, U.S. Forest Service) it is noted that the duration of maximum stress on a main structural part of an airplane, such as that occurring in a sharp pull out of a dive or maneuver, is maintained for only a few moments and the duration is assumed to be 3 sec. The chart (Fig. 1) shows the strength for a 3-sec loading to be 17% greater than that for a 5-min loading. Converting this value to the permanent loading basis by multiplying 117 by 1.777 gives a value of 207.9. Therefore wood can safely stand for the short period of 3 sec more than twice the load it could carry permanently.

POSSIBLE INCREASE IN WORKING STRESS

The possibility of increasing working stresses for loads lasting less than permanently appears worthy of the engineer's attention, for application to structures in a manner somewhat similar to that for aircraft. Increases could be used without reducing the factor of safety. As information for those who care to explore the possibilities in this direction, Fig. 1 is submitted. The data are applicable primarily to bending but in lieu of other information have been applied to other properties (except modulus of elasticity). The E value, which is the controlling factor in long columns (those of the Euler class), is of partial effect in columns of the intermediate class, and does not enter into the design of short columns. No increase on this basis could be permitted then for long columns or other members where deflection is the governing factor. Increases should be applied only to that part of the load which is definitely of a temporary nature, such as snow, and only where there is no possibility that it will later become permanent or that it will remain in place appreciably longer than contemplated.

In designing for wind loads, practice varies. Building codes frequently limit increases for use with wood to those for use with other materials or make a compromise value between the high of one material and the lows of others. Since the duration of the maximum wind load is considered as 5 min, the justifiable increase for lumber would be 77.8%.

Duration-of-stress charts show clearly why impact so rarely is a consideration in timber design. Questions have arisen as to the safety of running modern high-speed trains over timber bridges designed before such speeds were contemplated. The answer is: To run across at the fastest possible speed will not tax the capacity of the bridge as much as the same load at rest.

This discussion is based on test results for small clear specimens under laboratory conditions, which does not take into account circumstances sometimes encountered in practice. For example, foundation settlement and other readjustments of loads may in turn cause some readjustment within the timbers. The values in Fig. 1 for the longer periods or for initial periods when adjustment is taking place, should therefore be tempered by engineering judgment.

In addition to reduced duration-of-stress loading, there are other factors that would warrant increases in unit

CREOSOTED TIMBER BASE OF A DELAWARE BRIDGE
Triangular Plates, Called Shear Developers, Are Embedded in the Concrete Slab

stresses for timber and which also would not be at the expense of the factor of safety. One of these factors is "variability" within a species. Floor and roof joists act together, and therefore the deflection of the occasional "variable" piece would result in transference of load by bridging and sheathing to the stronger adjacent pieces. Failure of a single piece would not endanger the safety of the structure, and jobs under competent engineering supervision offer possibilities for advantageous placing and cutting of individual pieces. These are factors which discount the severe use conditions contemplated in the working stresses.

Recently considerable attention has been given to increasing working stresses through refinements in the design and manufacture of materials. Greater economy by means of higher working stresses is now feasible in timber design because of the careful stress-grading of lumber, improved fabrication, and more complete knowledge of the fundamental properties of wood.

Emergency City Planning for Wichita, Kans.

Difficulties Caused by New Housing Projects for War Workers

By P. L. Brockway, M. Am. Soc. C.E.
City Engineer, Wichita, Kans.

EXPANSION of the aviation industry at a rapid rate has brought large numbers of workers to Wichita. To properly house them various projects both private and federal have been undertaken. The location of these new developments has caused some consternation as to the effect on property values, and much activity in the city engineer's office to supply utility services. Mr. Brockway also explains the need for additional construction to care for the workers in the continuously expanding industries. This article has been condensed and revised since its presentation before the City Planning Division at the Society's 1942 Annual Meeting.

WICHITA, Kans., is located within a very short distance of the geographic center of the forty-eight states. At the junction of two non-navigable streams, it does not enjoy the advantage of water-borne freight rate competition, real or imaginary. It is a long distance to the primary markets, and freight differentials are an essential part of the price of everything that has to be moved.

On the other hand, it has a moderate climate both in temperature and rainfall. Fogs are practically unknown. Fuel is plentiful and cheap. There are no mountainous slopes or even high hills. Every pasture is a landing field for small aircraft. Freight is a minor item in materials for an airplane, and it is free from delivery charges on either land or water.

Consequently, there have been numerous attempts from the very beginning of aircraft manufacture to establish plants in Wichita. Most of them fell by the wayside. Three of them were going concerns when the defense industry entered the picture. All three were operating with a few hundred men each. All had small landing fields of their own and were near the municipal airport of 640 acres. All of them were also on a flat or only slightly rolling ridge of considerable width between adjacent watersheds and all within a very few miles of the city and along established highways.

LOCATION OF AIRCRAFT INDUSTRIES

The City Planning Commission lent its influence, largely through the administrative departments of the city, to the development of the physical structure of the municipality and environs, according to a "Comprehensive City Plan" prepared by Harland Bartholomew, M. Am. Soc. C.E., in 1921.

No concern was felt regarding the location of the aircraft industries through the years. They created no special problems except the minor ones of utility service. One of them indeed, located adjacent to the municipal airport and the airport itself, furnished the necessary final supporting argument for the opening and improving of a diagonal road from the city, which was a feature of the plan. The industrial expansion committee of the Chamber of Commerce worked early and late to attract and develop the aircraft industry and made some substantial progress through the years, but was handicapped by two important items—working capital and paying customers. All at once both of these were supplied in overwhelming volume, first in a small way by foreign nations and then by our own government in the all-out defense production.

Row of War Workers' Houses Completed in Five Months

The industries, already established in locations easily capable of expansion of plant and additional land, simply expanded and moved operations into new plant units on the heels of the construction gangs. This expansion still continues at such a rate that there is a definite need of providing space for thousands upon thousands of workers in a total period of not more than eighteen months. Utility service of all kinds has been expanded as the need requires, not without much discussion as to division of cost, and not without some trouble over delivery of materials, even with A-1-B to A-2 priorities.

LOCATION OF PARTS PLANTS

Secondary industries manufacturing machine or aircraft parts or complete small items have, for the most part, gone into existing plants. Others, more dependent on rail haul, have been built in areas already zoned for industrial development. The location of the major aircraft industries really constitutes a second belt of industrial use paralleling the first, far enough away to have little or no effect on residential use in the intervening area. The only problem is one of timing the further expansion of major highway capacities on locations included in the original city plan, and of acquiring the additional rights of way exactly in line with its recommendation. Timing is indeed important, because the local authorities find themselves unable to finance the additional highway capacity needed at this greatly accelerated rate. The one exception to the original plant of twenty years ago is that two diagonal highways have been built to extend in a direction different from that originally provided in order to serve industry better.

Not quite so simple is the secondary problem of housing the employees of the industry. Early in the period of accelerated employment, the local Real Estate Board established a Home Registration Bureau, which has been so well organized and operated that many of its features have been adopted as standard recommended practice by the Housing Division of the Federal Works Agency dealing with the housing of employees in defense industry. This Bureau actively solicited the listing of available rooms and apartments and encouraged renovation and subdivision of large old buildings into additional units. A survey of location of aircraft workers' quarters in midsummer of 1941 disclosed a remarkably uniform dispersion over the entire city. A fairly large percentage of the first few thousand of additional employees are unmarried. As time has passed and especially since actual war requires the active service in the

army of able-bodied single men, the trend is toward a larger percentage of married man and a very considerable percentage of women.

FEDERAL AGENCIES FINANCE HOUSING

There has, therefore, been considerable pressure for the construction of new family housing units. Federal mortgage guarantees through the FHA were made available to builders, first for homes built for sale and later for those for rent, to assist in supplying the demand. Private builders have completed about 2,900 family units in 1941. Even this was not enough to take care of the situation, and the Federal Government through the PBA built 400 family units which were occupied in September 1941. Another federal housing project of 600 family units was ready for occupancy in the early spring months of 1942 (Fig. 1). Five hundred trailer units installed by the Farm Security Administration will be ready for occupancy by late fall of 1942. Construction of 5,000 additional units has been started by the National Housing Authority for completion early in 1943. The population graph, Fig. 2, for the last twenty years indicates what these increases mean as compared with the normal growth of the city.

Conflicting and confusing estimates as to the need of additional housing facilities in 1942 tended to cloud the issue at the close of 1941. A local Defense Council was established by the city government in midsummer of 1941. One of its active committees concerned itself with the housing situation. Out of all the information from the Homes Registration Bureau, the aircraft personnel directors, the Real Estate Board, the building contractors, the utility groups, all of whom were represented on the committee, a definite report was compiled.

It was found at the close of 1941 that five thousand additional family units were needed to house the anticipated increase in defense workers and the other services to the workers themselves. By midsummer of 1942 this estimate was revised upward by reason of further industrial expansion to an indicated need of 12,500 family units. Thirty-five hundred of these could be supplied by private builders if they could be assured of financial support under conditions which would protect them from loss under changing price levels, and provided they could get materials promptly; also as an important

FIG. 1. HOUSING DEVELOPMENTS IN WICHITA, KANS., ARE CONVENIENT TO FACTORIES
(Plants and Airport Not Shown)

PROVIDING UTILITIES FOR AN EXTENSIVE HOUSING DEVELOPMENT

secondary consideration, provided that the existing OPM limitations on utility service were changed to permit occupancy of the homes when completed.

NEW UNITS BUILT BY THE GOVERNMENT

The other fifteen hundred family units of the 1941 estimate, and all of the additional 7,500 of the 1942 estimate, were to be built by the Government, practically all of them demountable so that they can readily be removed at the close of the emergency period.

Also, the committee made definite recommendations as to location of the federal housing projects. The most disconcerting detail in the whole expansion program is the location of these projects. The first one is named Hilltop Manor. It is literally on a hilltop within a half mile of the best residential section of the city—that is, best as regards attractive architecture and landscaping, which naturally means high values and taxes. It is about the same distance in the opposite direction from a very attractive suburban residential development. The topography is the most naturally attractive in or near the city. The barrack-type four- and six-family frame buildings erected at that location were most disheartening to owners of adjacent land, who had hopes of continued expansion of a consolidated, stabilized, high-value district.

As for the second unit, it was built in the same quarter section of land, tying in directly with the first, and consists almost entirely of two-family, one-story demountable frame houses. Local interests are hoping that the "best public interest" (quoting from the act authorizing the direct federal participation in defense housing) will cause them to be removed as soon as the emergency is over.

Local interests do not feel entirely blameless in the unfortunate location of these housing developments. Various groups with various ideas created such a state of confusion with their conflicting requests that the responsible federal agencies had to disregard practically all of them, and had little time in which to select sites when the need came.

The Housing Committee of the local Defense Council made definite recommendations of sites for future federal housing projects. It was hoped that some of these might be selected. They are so located that highway access and utility service is most readily available with the least initial cost and with the greatest residual benefit, even though they may later be entirely removed. After some of them had actually been selected and preliminary surveys made, the tire situation caused them to be abandoned in favor of sites closer to the plants.

As to private housing developments, there was a tremendous scouring of the community for locations where ten to two hundred houses could be built under the loan

PAVED STREETS BEING EXTENDED THROUGH A NEW RESIDENTIAL AREA

conditions laid down by the FHA. The City Commission had already adopted a fixed policy of refusing sewer and water service to locations outside the city except for the aircraft industries themselves. Some development has been made under requirements of enlarged lot area in those portions of the river valley where water is readily available and where septic tanks operate successfully.

Neither of these conditions applies to areas near the aircraft industries. While some plats have been filed entirely outside the city, most of them are lying undeveloped and will probably continue to do so until the city extends out to them. Tracts that have been developed within or adjacent to the city, at values low enough to be attractive, almost universally have some natural disadvantage which has caused them to remain dormant. One of them had unfortunate rectangular platting which fought with the topography. Rather expansive grading, amounting to $150 per site, corrected that and brought the tract into a productive taxable position. Drainage problems affect most of them. The city felt justified in spending rather considerable sums in drainage structures where immediate development was assured.

There have been some differences of policy between the City Planning Commission and the FHA supervisors in the layout of new subdivisions. However these have been readily adjusted and, with concrete examples before them, the builders are now readily accepting contour platting even at the loss of a few building sites. As the need of conserving critical materials became more evident, the FHA more readily approved loans in established neighborhoods where utilities and street improvements were already installed.

PROPERTY VALUES MUST BE PROTECTED

The outline map, Fig. 1, shows the location of the principal tracts developed in 1941 and up to September 1942, in relation to the major street system. It also shows the location of those under discussion as possibilities for further development. It is easily seen that they are in a rather well defined peripheral zone, so distributed as to comprise a logical, orderly development. There are, of course, many isolated single or group sites of small extent within this periphery which are undeveloped, even though highway and utility services are already available. There are generally one or all of four things which operate against them: (1) the difficulty of obtaining clear title through estates, (2) an unattractive neighborhood from the standpoint of stable loan value on a long-time basis, (3) unpaid accumulated taxes amounting to as much as, or more than, the market value, and (4) the fact that they are being held at more than current market value.

The Federal Government could cut through all these difficulties in larger tracts, but generally speaking they are major problems and stand in the way of intelligent, orderly city development. It is going to require considered legislation, wisely and impartially administered, to solve them.

In closing, reference must be made to the extreme difficulty of logical planning due to the state of confusion that has existed ever since the need for housing expansion began to be felt. This difficulty still exists because of uncertainty as to the availability of critical materials.

MATERIALS FOR HOUSES NOW SCARCE

The 1941 schedule of necessary additional housing units, set up by the local housing committee, was approved by the responsible federal agency at the close of the year. At the same time another federal agency reported that there was no need for additional federal units. The situation changed so rapidly that in the very early spring the local housing committee, with the information at hand at that time, recommended a very material increase in the necessary housing units to be constructed by the Federal Government. This recommendation was again approved by the National Housing Authority and locations were selected in line with local recommendations. However, as has already been stated, these locations were abandoned because of the impending shortage of rubber for tires. These various changes of front and planning brought about by national emergencies of various kinds have delayed the actual construction until a time when the materials necessary to build houses are extremely scarce.

The City Planning Commission made a recommendation to the City Commission that certain regulations as to location of house cars or trailers be relaxed for the duration of the war. It is believed that this might add several hundred to the number of family shelters.

We do not suggest that this situation is in any way unique. These things are related only to indicate the difficulty of planning and staying with logical plans in the face of the present national emergency. The housing need is still very, very acute, and there does not appear to be any immediate adequate solution. The number of housing units needed has surpassed all former estimates but cannot be given in detail for military reasons.

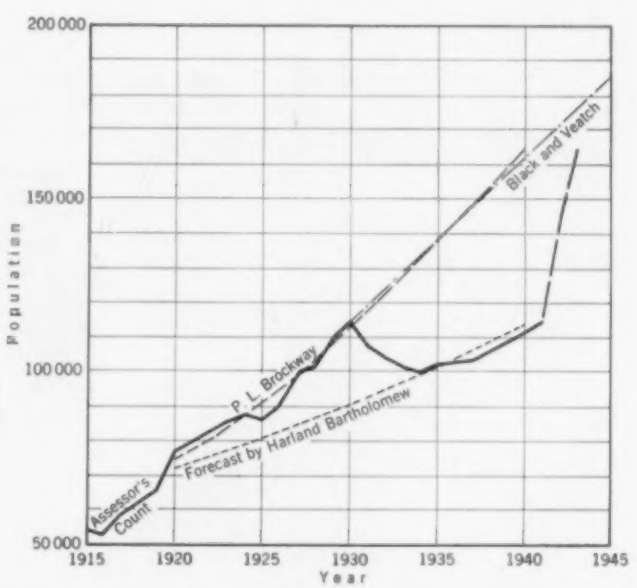


FIG. 2. POPULATION FORECASTS CONTRASTED WITH ASSESSOR'S COUNT FOR WICHITA, KANS.

Steel Piles for Subaqueous Work

By G. G. GREULICH, ASSOC. M. AM. SOC. C.E.
SALES REPRESENTATIVE, CARNEGIE-ILLINOIS STEEL CORPORATION, PITTSBURG, PA.

THE life of harbor facilities, barring accident, is dependent upon the rate of deterioration of the underwater structure. Marine life, chemical action, abrasion, and repeated shock add to the destructive forces tending to hasten the day of necessary replacement. Mr. Greulich has investigated the relative effects of these actions and has discussed protective devices in this paper, which was originally presented before the Metropolitan Section at one of its recent meetings.

HARBOR facilities are usually constructed along protected waters, and for that reason are not subjected to the violent abrasive action of sand-laden waves or currents, or to repeated flexure or shock which tends to loosen or remove the protective layers of oxidized materials on the surface of the steel. In rare instances, as in the case of certain California oil piers, they may be located on exposed shore lines. The changes in water level encountered affect the nature of the protective devices needed and the elevations at which they are required. The amount of rise or fall and the velocity of currents are determined by magnitude of tides, runoff conditions in contiguous streams, and the direction and velocity of winds. Harbors may be located on either fresh, brackish, or salt water. Generally speaking, steel structures in fresh water areas have a much greater life than those built in salt water.

To make an intelligent determination of the precautions to be observed, we should know something of the past history of similar structures and of any objectionable conditions that may have developed. A considerable number of unprotected steel waterfront structures, built on both fresh and salt water, are rendering satisfactory service. Periodic examination has revealed certain deficiencies and pointed the way to the most desirable and effective remedial or preventive measures, as will be here discussed.

STEEL-PLATE PROTECTION FOR STEEL PILES—WELDING IN PROGRESS

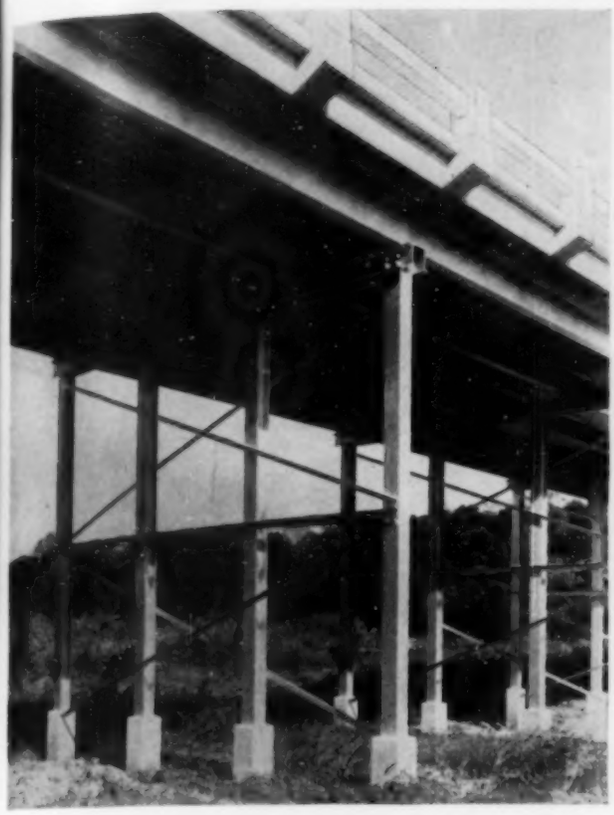
Deterioration of unprotected steel in fresh water is usually very slow. Examination of numerous structures shows that rarely were any provisions made for protection. Sometimes traces of an original coat of shop paint can be found after twenty or more years of exposure. There are instances on record of piles withdrawn after supporting bridge superstructures for twenty-five years or more, until the bridges had outlived their economic usefulness. These piles were subsequently turned end for end and redriven to serve as the foundations for new bridges. In recent years there has been a growing tendency to encase or coat steel piers for protection when they are constructed on river harbors, where there may be a relatively rapid rise and fall in water level, combined with swift currents carrying considerable abrasive material.

UNPROTECTED STEEL PILES, SHOWING ACCUMULATION OF EMULSIFIED OIL

Examination of numerous steel structures located in salt water also shows that rarely were any provisions made for the protection of the steel. Even after these structures have been in service for 25 to 35 years, the steel is usually found to be in excellent condition below the low-water line, fair to poor between high and low water, and poor above the high-water line. In the relatively few instances where traces of coal tar or other coatings still adhere, the condition of the steel in the upper zones is much better than in cases where the steel was left unprotected.

The behavior of large quantities of full-sized members of ordinary medium-carbon-steel, driven with mill scale attached, has apparently been much better than is indicated by tests of small totally immersed specimens of comparable grade. These tests have been made by the British Institution of Civil Engineers over a 15-year period.

Conditions at Plymouth, England, were assumed to be similar to those of our temperate zone, and conditions at Colombo, Ceylon, similar to those of our subtropical Florida and Caribbean areas.



CONCRETE ENCASEMENT BELOW AND ABOVE THE GROUND LINE

On the basis of 15-year losses of metal from corrosion or other causes, the report of the British Institution shows that the following number of years are required for a loss of $^1/_{16}$ in. of steel from the surface:

	ABOVE WATER	WET AND DRY	IMMERSED
Colombo	6 years	7 years	14 years
Plymouth	10 years	27 years	28 years

Whereas these reports show an equivalent loss of metal of $^1/_{16}$ in. in 14 years' immersion at Colombo, steel immersed for 31 years at Dry Tortugas Islands, Gulf of Mexico, showed a loss of only $^1/_{32}$ in. Fabricated-type steel sheet piling, driven in 1906 and 1907 at Guantanamo, Cuba, showed the steel shapes and rivets to be in perfect condition below the low-water line in 1939, while the portions above that level were practically destroyed. Fabricated Freistedt-type piling, used temporarily twelve times between 1907 and its permanent installation in 1912 in a harbor bulkhead at Key West, was inspected in 1936, when the original mill name branding, as rolled on the steel, was found to be clearly visible and intact below the low-water line.

The corrosion loss of steel at Plymouth in the wet and dry zone was $^1/_{16}$ in. in 27 years. Specimens of plate and sheet piling, removed at Glenwood Landing, N.Y., in 1929 from the apparent zone of worst corrosion about 1 to $1^1/_2$ ft below high water, showed losses in thickness of $^1/_{32}$ in. in 21 years, and $^3/_{64}$ in. in 11 years, respectively. These rates are roughly equivalent to twice that at Plymouth.

Steel piles are widely used without any protective applications whatsoever when they are entirely embedded in earth or completely immersed in water. Under these conditions, nearly all atmospheric oxygen is blanketed off by the surrounding soil or water, thereby inhibiting progressive corrosion. Unprotected steel piles are often used even when they extend above the surface of the water. In certain harbors, the presence of oil on the water surface results in the accumulation on the pile surfaces of an emulsified protective coating, as shown in an accompanying photograph by the dark discoloration of piles immediately above the water surface. The sharp definition of the high-tide line formed by emulsified oily deposits on structures on the Delaware River near Philadelphia is most pronounced.

In recent years, there has been an increasing tendency to apply some form of protective coating either before or after installation. Such coatings are applied most often from slightly below low water up to a point where the structure can be protected by ordinary maintenance; less often from slightly below low water up to and including all exposed under sides of superstructure material; and seldom from below the mud line up to either of the preceding upper limits.

EFFECTIVENESS OF SURFACE COATINGS

The effectiveness of such coatings depends, in large measure, on the preparation of the steel prior to their application. At the present time the flame-cleaning method is apparently giving the best results, and it is especially desirable in cases where the steel has been exposed to the weather for a considerable period before coating. New steel, which has not been allowed to rust and has only a normal covering of mill scale, can be given a surface coating with fairly satisfactory results after normal cleaning and wire brushing. Even for such steel, however, the application of the flame-cleaning method may give additional benefits.

After cleaning the surface, generally satisfactory results are obtained from the application of a minimum thickness of $^3/_{32}$ in. of a coal tar base enamel, free from native asphalt and petroleum derivatives. However, a primer and a coat of paint of similar material may be applied in place of the enamel. After the coating has been applied, care must be taken in storing, handling, and driving to keep it from being damaged. Damaged areas, of course, should be patched while they are still accessible, either during or after driving. Where welded

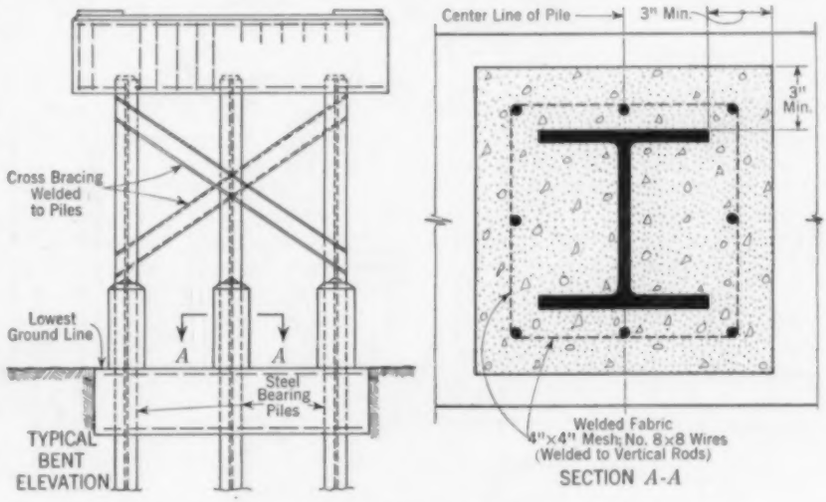


FIG. 1. COMBINATION REINFORCED CONCRETE MUD SILL AND PILE PROTECTION

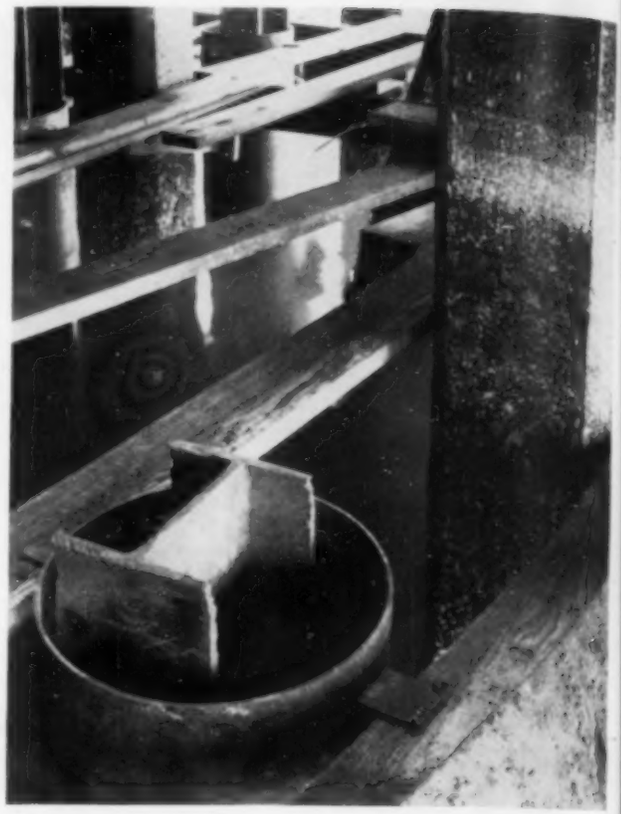
connections are used, coatings are omitted in the areas affected, and a thin covering of oil or primer is applied instead. After completion and cleaning of the welds, the regular coatings of paint or enamel are applied.

ENCASEMENTS FOR STEEL PILES

One of the most satisfactory encasements for a steel pile is a welded steel-plate enclosure for pile sections. Typical details of such an application are shown in an accompanying photograph. Plates $^1/_4$ in. thick so attached should give protection for at least 25 years before requiring replacement. These plates are normally welded on to the pile before driving. Occasionally upward extensions can be applied to piles after driving in localities where penetrations are found to be very irregular. This form of protection is rugged and is not injured by severe driving or rough handling. Furthermore, it is not bulky so that it does not interfere with loading or require more room in storage, and the cost is moderate.

The most commonly used encasement is concrete applied above and below the ground line in stream beds or other localities where inundation is infrequent. Details are shown in an accompanying photograph. A modified form of concrete encasement includes the monolithic concrete mud still below the ground line, as shown in Fig. 1. This form of encasement is frequently employed in streams subject to flash floods with attendant swift currents and floating debris. It is also useful where great resistance to the thrust of ice floes, or an unusually rigid structure, is required.

Where it is desired to protect the upper end of a steel pile by a concrete encasement without resorting to prior excavation, a useful method is shown in Fig. 2. This method is particularly useful when the upper portion of the pile passes through deleterious fill such as unleached cinders or ash or soil saturated with acid or corrosive alkaline industrial wastes. Piles completely encased from below the mud line to the underside of the superstructure form a very rigid bent with its rugged concrete sill just above the water line, and are particularly useful when the structure is exposed to water with heavy ice floes or to high winds with attendant salt spray. This method is also useful when the piles pass through water highly polluted with sewage or mine waste, and when the mud at the bottom of the water is full of decaying marine animal or vegetable matter.



H-PILE WITHIN STEEL SHELL BEFORE POURING CONCRETE CAP

A view of field application of another method of applying encasement below water and in underlying mud, without prior excavation, is shown in an accompanying photograph. The steel shells are ordinarily forced down to a point below the mud line with a tight form collar fitted to the H-beam and the lower end of the steel shell secured rigidly to the collar. The shell is forced down by driving either directly on the shell or on timber struts resting on the collar, and where necessary, by the application of water jets below the collar. After the shells are filled with concrete, the upper portion of the pile bent is constructed. The use of permanent steel shells is particularly desirable where the sharp cutting and grinding edges of ice floes are encountered.

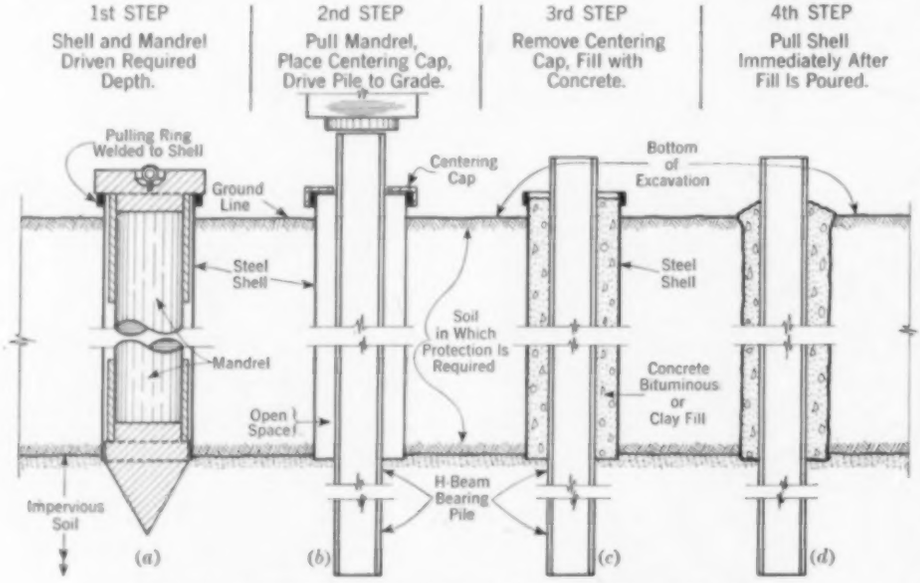


FIG. 2. PROCEDURE WITH DRIVEN FORMS, WHICH ARE WITHDRAWN AS CONCRETE IS CAST IN PLACE

Prior to driving, gunite may be applied to steel H-piles from any point selected above the high-tide level down to any point below the low-tide line, or even several feet below the mud line. Where the gunite encasement is adequately reinforced and the gunite has been sufficiently cured, piles have been driven without any apparent damage to the encasement.

Under conditions where it is feasible to drive closely spaced, heavily loaded end bearing piles to refusal in hardpan or rock, a very effective means of transferring the load from the superstructure, as well

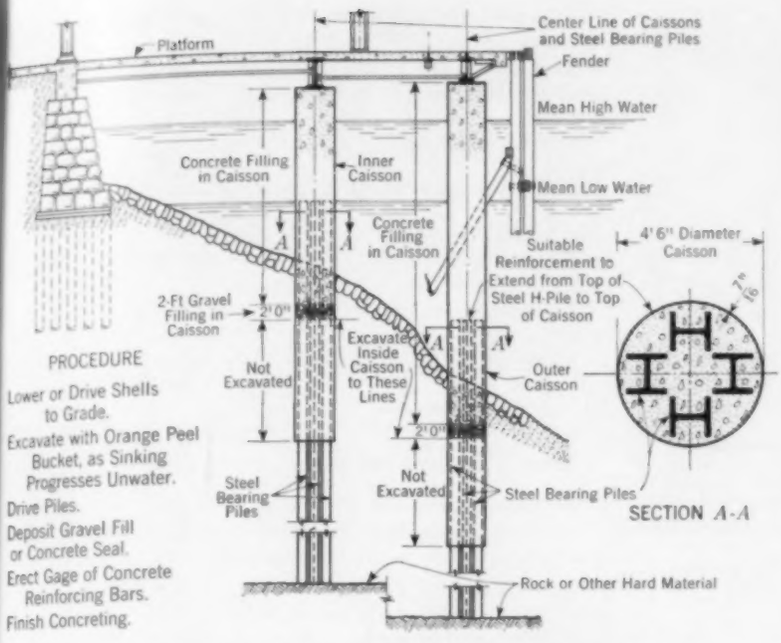


FIG. 3. DETAILS OF BEARING PILES AND CAISSONS FOR PIERS

as affording an efficient protection against corrosion, is shown in Fig. 3. It will be noted that heavy wall shells are first placed in position, the steel piles are then driven inside the shells, and concrete filling is deposited in the shells or caissons to a point well below the tops of the piles, as well as below the mud line. It is apparent that, in addition to providing protective encasement, the disposition of the materials used results in a rugged pier, highly resistant to lateral as well as vertical forces. Encasement is normally applied to a point well above the spray line, or else to a location convenient for the application of paint or other surface coating that may be renewed from time to time.

This information has been collected and these practices developed during the brief interval of the past eight years The rapid development of welding technique and its expanding use are tending more and more to field welding with a consequent reduction in shop fabrication of structural components. This, in turn, is leading to simplification of design and the elimination of cumbersome details, which were difficult and expensive to protect and encase. The small areas immediately adjacent to and over the welds may be readily covered and protected after welding, whereas all other portions of a structural member, except those parts immediately in contact with the welds, may be readily coated at or near the site prior to placing in final position in the structure.

In some cases, it will be found more economical to increase the thickness of steel members and use them unprotected to avoid the expense and delay attending the application of encasements. This is especially true of structures intended for limited life. The use of slightly heavier steel members involves only the purchase of additional low-priced steel. There is no increase in the number of pieces to be handled. There is only a small increase in weight and cost of the final installation. Careful choice of the solution applicable to a particular problem leads to an efficient and versatile use of steel in harbor facilities combined with the assurance that a permanent and durable structure will be provided.

Engineers' Notebook

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

Solving for Moments in a Continuous Beam by One Unknown

By J. CHARLES RATHBUN, M. AM. SOC. C.E.

PROFESSOR OF CIVIL ENGINEERING, COLLEGE OF THE CITY OF NEW YORK, NEW YORK, N.Y.

SOLUTION for moments in a multiple-span continuous beam ordinarily involves the solution of a set of simultaneous equations in several unknowns. It would seem advantageous to reduce this to a solution of several equations with but one unknown. This can be done if it is recalled (1) that the moment at one end of a beam can be determined by the area moment method if the moment at the other end is known; and (2) that the slope at the end will be the difference between the slope at the first end and the area of the M/EI diagram between these points.

The solution is best demonstrated by an example. A continuous beam of four spans is shown in Fig. 1 (*a*) with properties and loads. Relative values only of EI are given, as exact values are not needed unless the slope is required. The M curve is shown in Fig. 1 (*b*), containing the unknown values M_B, M_C, M_D. For convenience, the moment curve may be considered as a combination of the moments caused by the unknown moments at the supports (lower line) and the moments caused by the applied loads in the spans of application (triangle and parabola).

The triangles have the area $M/2EI$ or $M/2K$. The area of the triangle cdf is equal to $\frac{150 \times 6 \times 12 \times 18}{18 \times 2 \times 2 \times 18}$, or 75, with the center of gravity $\frac{12 + 18}{3}$, or 10 ft from C. The area of the parabola fgh is equal to $\frac{12 \times 18 \times 18 \times 2 \times 18}{2 \times 18 \times 8 \times 3}$ or 162.

In span AB assume that the slope at A is $4x$, and that

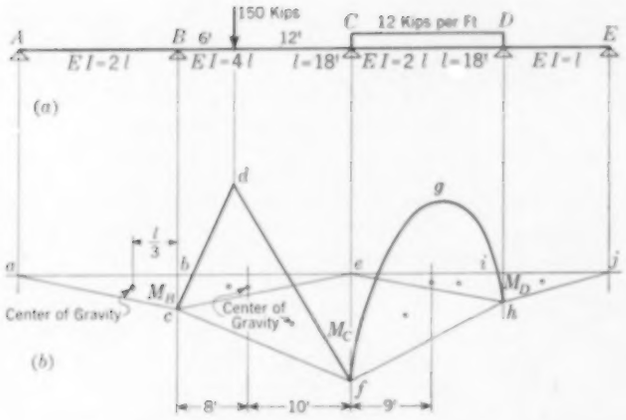


FIG. 1. CONTINUOUS BEAM WITH FOUR SPANS

M_A equals zero ($4x$ was used instead of x to avoid fractions). In the case of a fixed end, the slope is taken as x at B, from which M_A is computed.

The area of triangle abc is $\frac{M_B l}{2EI} = \frac{M_B}{2 \times 2} = \frac{M_B}{4}$.

Deflection from the tangent at A of point B equals $(4x)l + \frac{M_B l}{4 \times 3} = 0$, whence $M_B = -48x$.

The area abc equals $-12x$, and the slope at B is $-12x + 4x = -8x$.

The same procedure is followed in span BC, where area of triangle bce is $\frac{1}{2}$ abc, or $-6x$, and the area of triangle cef is $\frac{M_C l}{2EI} = \frac{M_C}{8}$. Then,

$\left(\frac{M_C}{8}\right)\left(\frac{l}{3}\right) - (6x)\frac{2l}{3} + (75)(10) - (8x)l = 0$, or $\frac{M_C}{8} = 36x - 125$

and the slope at C is $(-8x) + (-6x) + (75) + (36x - 125) = 22x - 50$.

Proceeding to span CD, area $ehf = 2cef = 2(36x - 125) = 72x - 250$.

Then $(22x - 50)(3) + (72x - 250)(2) + (162)(1\frac{1}{2}) + \frac{M_D l}{2EI} = 0$.

From this, area $eih = \frac{M_D l}{2EI} = -(210x - 407)$.

Similarly, area $ihj = -420x + 407$.

At D the slope is $(22x - 50) + (72x - 250) + 162 + (-210x + 407) = -116x + 269$.

Since the moment at E is zero, $\frac{2}{3}(-420x + 814) + (-116x + 269) = 0$, or $594x = 1{,}217.5$. Solving for x and substituting back: $M_B = -48x = -98.38$; $M_C = 8(36x - 125) = -409.70$; and $M_D = 4(-210x + 407) = -93.72$.

Gage to Measure Crest Stages of Streams

By G. E. FERGUSON, ASSOC. M. AM. SOC. C.E.
DISTRICT ENGINEER, U.S. GEOLOGICAL SURVEY, OCALA, FLA.

AT present the U.S. Geological Survey is operating gaging stations at more than 4,200 places on streams in the United States. At a small percentage of these places it is impracticable to install a water-stage recorder for obtaining continuous records. At these places, gage readings taken one or more times daily by a local observer can be supplemented advantageously by a device for recording maximum stages. During recent years many types of auxiliary gages for this purpose have been devised and tried. (See articles by Capt. Floyd J. Doran and M. H. Collet, respectively, in the February and July 1942 issues of CIVIL ENGINEERING.)

Such a gage should meet the following requirements: (1) it must be sufficiently indestructible to withstand the force of flood water and the accompanying drift, the destructive tendencies of vandals, and the target practice of thoughtless hunters; (2) it must be practically constructed so as to operate successfully in the silty waters of floods; (3) it must be simple enough to be tended by observers of limited ability, and maintained by infrequent visits of Survey engineers; (4) it should be of a design that can readily be constructed of materials, and with facilities, ordinarily available in the field; and (5) it should be low in cost.

An auxiliary gage, shown in Fig. 1 and in a photograph, has been developed to fill these requirements. It consists of three parts: (1) a stilling well of 2-in. pipe fastened vertically to a bridge abutment, wing wall, or similar substantial backing; (2) a removable wooden inside staff; and (3) a marking substance that will float on water.

At the lower end the pipe is closed with a coupling and screw plug to which is fastened a platform on which the staff will rest, and at the upper end with a cap and locking device. Quarter-inch holes are drilled in the coupling about 1 in. above the bottom, leaving a stilling well in which the marking substance may be deposited. The pipe is extended low enough to operate during all ordinary crest stages, but not so low that it will become silted by changes in the stream bed. It is extended above the top of the supporting structure to a height sufficient for convenience and safety in reading and to insure a record of the highest stage anticipated on the stream.

The inside staff is of wood, $\frac{7}{8}$ by $1\frac{1}{2}$ in. in section, with a metal plate at the bottom to rest on the support in the stilling well, a lead plate fastened to the back to eliminate buoyancy, and metal plate at the top to

CREST-STAGE GAGE INSTALLED ON BRIDGE WING WALL, NORTHEAST BRANCH OF ANACOSTIA RIVER, AT RIVERDALE, MD.

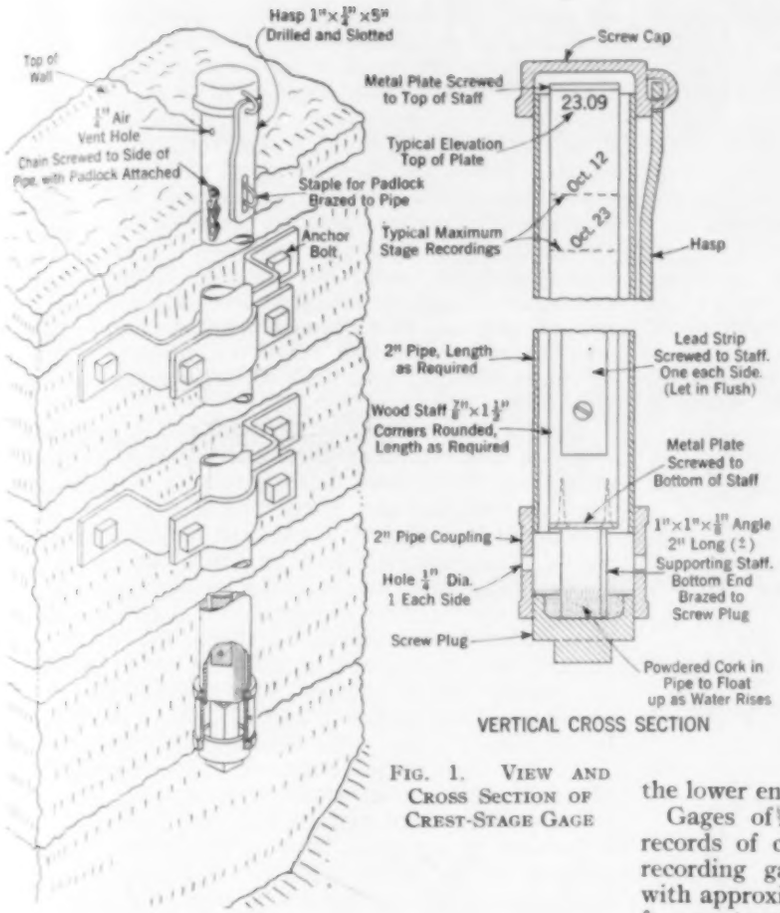

Hasp 1"×¼"×5" Drilled and Slotted
Screw Cap
Top of Wall
Metal Plate Screwed to Top of Staff
23.09
1/4" Air Vent Hole
Typical Elevation Top of Plate
Chain Screwed to Side of Pipe, with Padlock Attached
Staple for Padlock Brazed to Pipe
Oct. 12
Oct. 23
Anchor Bolt
Typical Maximum Stage Recordings
Hasp
2" Pipe, Length as Required
Lead Strip Screwed to Staff. One each Side. (Let in Flush)
Wood Staff ⅞"×1½" Corners Rounded, Length as Required
Metal Plate Screwed to Bottom of Staff
1"×1"×⅛" Angle 2" Long (±) Supporting Staff. Bottom End Brazed to Screw Plug
2" Pipe Coupling
Hole ¼" Dia. 1 Each Side
Screw Plug
Powdered Cork in Pipe to Float up as Water Rises
VERTICAL CROSS SECTION

FIG. 1. VIEW AND CROSS SECTION OF CREST-STAGE GAGE

serve as a reference plane in determining elevation with respect to gage datum. The staff is graduated in feet and tenths for indicating elevations above gage datum. Installations that are visited by an observer unskilled in gage reading need not be graduated.

After several experiments, fine regranulated cork was selected as the marking substance. Staining substances, such as lampblack or charcoal, or water-marking types of paints, were rejected because they would require frequent refinishing of the staff. Operation has shown that cork will not only mark the highest crest, but also will mark successively lower crests, leaving a sharp, distinct line of grains at each crest stage. About 1 cu. in. of cork is usually sufficient for a charge.

The gage is read by removing the staff from the pipe and noting the gage height of each crest mark. If the staff has not been graduated, the observer is instructed to remove the staff after each rise; mark a horizontal line with a soft pencil at the crest, as shown by the cork deposit; write the date and approximate time of occurrence, if known, near the line; brush off the cork deposit; and replace the staff in the pipe. The engineer, on visiting the gage, determines the gage height of each mark by measuring down from the reference plate at the top of the staff, which is at a known height above gage datum. He then erases the notations and the lines. Additional cork is deposited in the pipe when necessary.

Construction of these gages is facilitated by making up in advance a supply of top sections about 18 in. long, complete with padlock staple and chain bolt. A stock supply of screw plugs and couplings for the lower end is also desirable.

Gages of this kind are used mainly for obtaining records of crest stages at stations not equipped with recording gages. The recorded crest stage, together with approximate times of occurrence, provides a means for constructing reasonably accurate stage graphs when used in conjunction with the readings of an observer. These gages also have an important use in investigating the physical characteristics of a channel reach by providing a precise and economical method of determining crest stages, from which the slope of the water surface during the passage of a flood may be computed.

The cost of these gages is reasonable. A complete installation seldom comes to more than $40, and the average is about $25.

Flood Hydrographs

By G. G. COMMONS

OFFICE ENGINEER, TEXAS BOARD OF WATER ENGINEERS, AUSTIN, TEX.

THE study of major floods has disclosed what appeared to be a regular pattern of distribution of the flow. This pattern may be obscured by secondary peaks, occurring before or after the main peak, or by the recession curve of an antecedent flood. However, in major floods having a single peak, it was found that the rate of rise was about $1\frac{1}{2}$ times as rapid as the rate of fall, that on a plotted hydrograph, the rise from about $\frac{1}{3}$ to about 95% of the peak flow was practically a straight line, and that the fall over the same range was also practically straight.

Various hydrographs were prepared and tested against actual flood hydrographs, as given in the publications of the U.S. Geological Survey. Only those floods were used where the data showed the flow at close intervals, one hour to (in the later stages of the flood) six to twelve hours. The attempt was to secure a close fit over the critical portion of the hydrograph, from about 20% of the peak flow to the peak on the rising side, and from the peak to about 30% of the peak on the falling side. Since this was developed for Texas conditions, particular attention was paid to floods in Texas and similar areas. However, it was found that the developed hydrograph fitted equally well for floods in Connecticut, New York, Pennsylvania, and other areas.

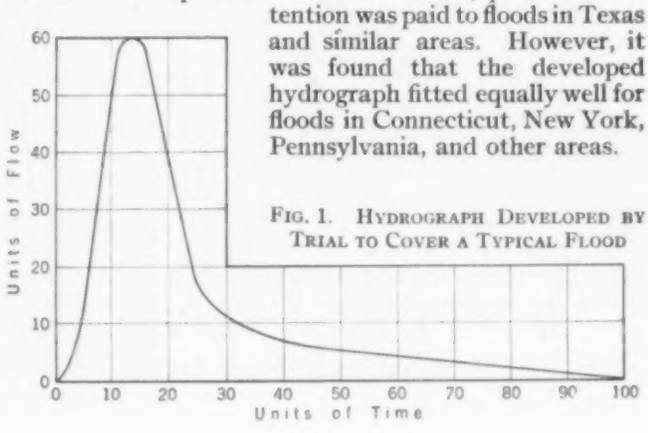


FIG. 1. HYDROGRAPH DEVELOPED BY TRIAL TO COVER A TYPICAL FLOOD

In Fig. 1 is given the hydrograph as developed by trial. The base (time) has been divided into 100 units, and the height (rate of flow) into 60 units. The area under the curve is 1,196.5 "square units" (time multiplied by rate of flow). If the total flood flow in acre-feet is divided by 1,196.5, it will give the value of one "square unit" in acre-feet. Dividing the peak flow in cubic feet per second by 60 gives the value of one unit of flow in cubic feet per second. Since 1 cu ft per sec is approximately 1 acre-ft in 12 hours, there results

$$\frac{\text{Value of 1 "square unit"} \times 12}{\text{Value of 1 unit of flow}} = \text{Value of one unit of time in hours.}$$

For example, assume a runoff of 5.5 in., over a drainage area of 4,480 sq miles, with a peak flow of 325,000 cu ft per sec. The computations necessary are:

$$\frac{5.5 \times 4{,}480 \times 640}{12} = 1{,}314{,}000 \text{ acre-ft of runoff} \quad (1)$$

$$\frac{1{,}314{,}000}{1{,}196.5} = 1{,}098 \text{ acre-ft} = \text{value of 1 "square unit"} \quad (2)$$

$$\frac{325{,}000}{60} = 5{,}417 \text{ cu ft per sec} = \text{value of 1 unit of flow.} \quad (3)$$

$$\frac{1{,}098 \times 12}{5{,}417} = 2.43 \text{ hours} = \text{value of 1 unit of time} \quad (4)$$

In Figs. 2 and 3 are shown the application of the hydrograph to floods from areas of 356 and 203,000 sq miles, respectively, and having durations of about three days and four months, respectively. In Fig. 3, the presence of a secondary or minor peak at about January 10 is quite noticeable. Were it not for this minor peak, the fit of the developed hydrograph would be much better.

In the studies leading up to this hydrograph, an effort was made to use the unit hydrographs as given in U.S. Geological Survey Water-Supply Paper No. 772. It was found, however, that these unit hydrographs were based on average daily flows, and did not define the peak flow with sufficient accuracy or detail.

This flood hydrograph may be defined as the normal distribution of a given amount of runoff from a single storm, when the peak rate of flow is also given. It should be noted that the shape of the hydrograph is quite similar to those developed by other and more laborious means. Since it is based on the assumption that the peak flows from all the tributaries are in phase, its particular use would be in developing a hydrograph for a maximum flood, for routing through a reservoir, or along a river course. Since, for these purposes the important parts are the rising side, the duration of crest, and the falling side (down to perhaps one-half the peak flow), the fit of the hydrograph in the recession period is not of great importance. In the development of this hydrograph, an attempt was made to lengthen out the recession period, but it was found that changes in the portion below one-third the peak flow had very little influence on the fit of the critical portion, that is, the portion above one-third the peak flow.

Determination of the total runoff can be made from a study of precipitation records and of the soil types and conditions. The more difficult task of determining the peak rate of flow can usually be accomplished by the plotting of maximum floods against drainage areas (preferably on logarithmic paper), for similar climatic and topographic conditions, and from the envelope curve of such maxima, determining the probable maximum for the area under consideration. It should be noted that in plotting large numbers of such floods, a distinct break in the envelope curve occurred in the neighborhood of 1,000 sq miles. Water Supply Paper No. 847 of the U.S. Geological Survey is especially valuable in this work.

Another field of usefulness of this hydrograph is in filling in missing portions of hydrographs, particularly where only fragmentary records are available.

Further study may, and probably will, result in changes in this hydrograph. It is felt, however, that such studies will not materially affect the shape of the important part of the curve, nor will they invalidate the principles on which it is based.

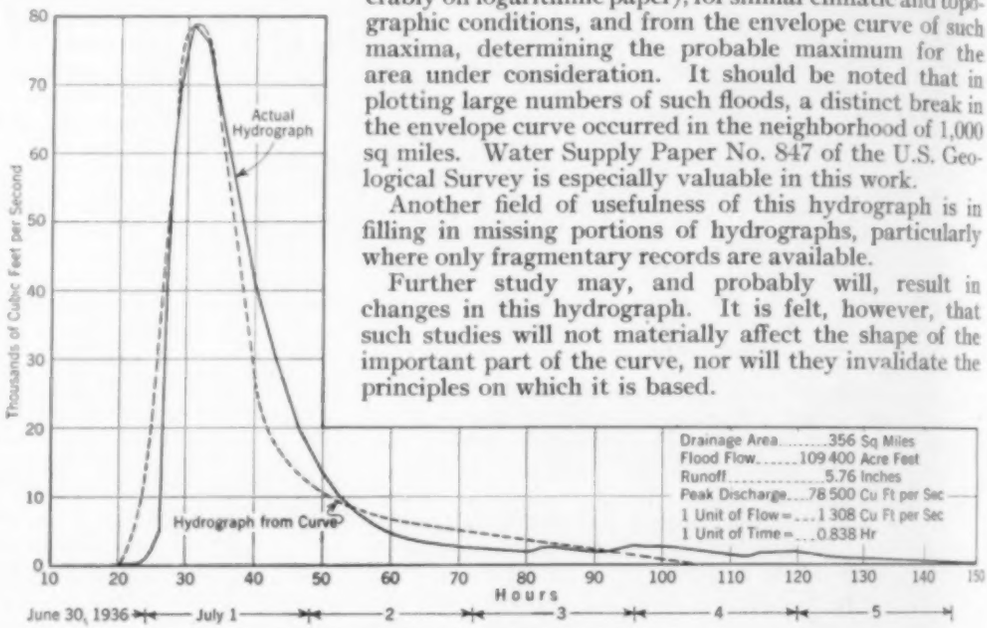


FIG. 2. HYDROGRAPH FOR PLUM CREEK FLOOD SUPERIMPOSED UPON TYPICAL CURVE

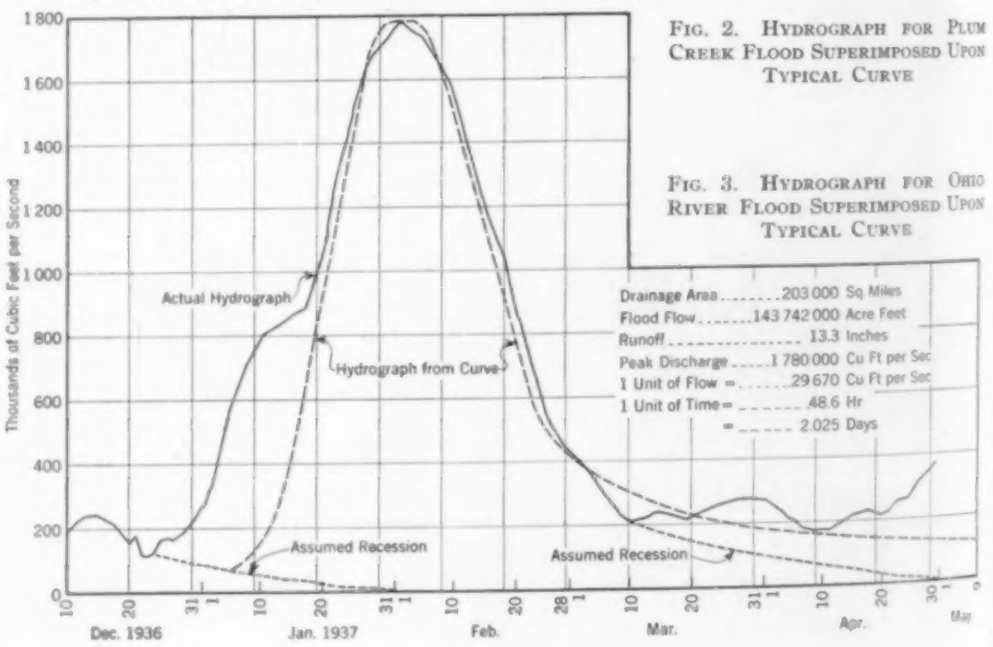


FIG. 3. HYDROGRAPH FOR OHIO RIVER FLOOD SUPERIMPOSED UPON TYPICAL CURVE

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Solutions by Least Work and Other Methods

TO THE EDITOR: The solution for a frame of multiple redundancy by the method of least work, given by Mr. Laughlin in the July issue, can be found by assuming a load in the member AB with the corresponding deflection at B. From this we can find the loads and deflections at E, G, F, and D that correspond to our assumed load. The actual stresses are then in proportion to our given load. The calculations are no longer than those given by Mr. Laughlin, and the formulas used are those given in the A. I. S. C. handbook for simple spans.

Assume tension in AB = 1,000 lb, then deflection = $\frac{PL}{AE}$ = $\frac{3,333}{10^6}$ in.

Beam BG has a concentrated load P, at the mid-point, causing a reaction at the left end of 1,000 lb with a corresponding deflection of $3,333/10^6$.

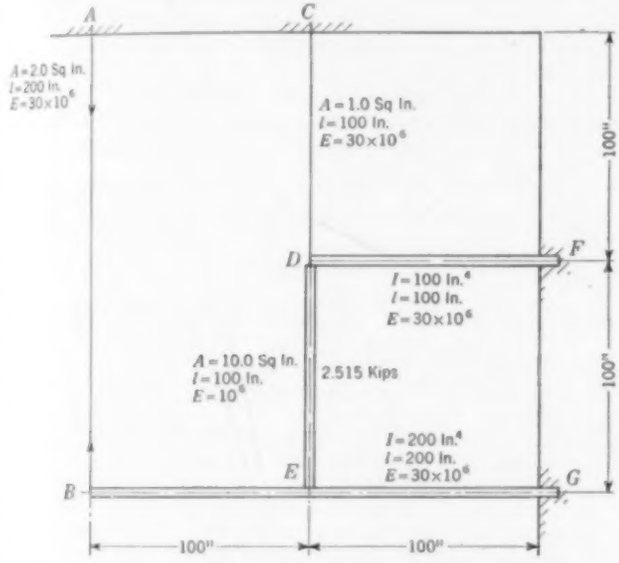


FIG. 1. STATICALLY INDETERMINATE FRAMEWORK

Due to this deflection of support B the load on member BG is P_1 = $\frac{3EI\Delta}{L^3}$ = 7.5 lb, $\therefore \frac{5}{16}P - P_1$ = 1,000 lb. P = 3,224 lb; reaction at G = $\frac{11}{16}$ 3,224 + 7.5 = 2,224 lb; and moment at G = $\frac{3}{16} \times 3{,}224 \times 200 + 7.5 \times 200$ = 122,400 in-lb.

Deflection at E from line BG is the deflection of cantilever $\Delta = \frac{P_1}{6EI}(2L^3 - 3L^2x + x^3) = \frac{1{,}041.67}{10^6}$ plus the deflection of the beam fixed at one end and supported at the other. Here L = 200 and x = 100. Δ at point $E = \frac{7}{768}\frac{PL^3}{EI} = \frac{39{,}181}{10^6}$. Total = $\frac{40{,}222}{10^6}$.

Since the load in member DE is P = 3,224 lb, this member has shortened $\Delta = \frac{PL}{AE} = \frac{32{,}224}{10^6}$, and point D must be $\frac{32{,}224}{10^6} + \frac{40{,}222}{10^6} = \frac{72{,}446}{10^6}$ below F. Then the load in CD would be $P_2 = \frac{AE\Delta}{L}$ 21,730 lb. And the load carried by the beam DF is $P_3 = \frac{3EI\Delta}{L^3}$ = 652 lb, and the moment = 652 × 100 = 65,200 in.-lb.

ΣV at D = 0. 3,224 + 21,730 + 652 = 25,606, which is the applied load. $\therefore$ If we have a given applied load at D, the actual loads would be in proportion. For example, if the given load is 20,000 lb, then the load in CD would be $\frac{20{,}000}{25{,}606} \times 21{,}730 = 16{,}970$ lb.

PAUL F. CAMPBELL, Assoc. M. Am. Soc. C.E.
Structural Engineer, The Rust Engineering Company
Pittsburgh, Pa.

TO THE EDITOR: In CIVIL ENGINEERING for July, Mr. Laughlin very clearly explains the application of the method of least work to a problem of multiple redundancy. It appears that the work involved may be shortened somewhat by use of another method.

Let us assume a load in the member AB of unity, find the deflection at D from the system $ABEG$, find the loads carried by CD and DF at this deflection, and then adjust the loads, in the same ratio, to equal the imposed load. E will be taken as relative unity, and all deflections and loads will therefore be relative only. The joints B, E, and D are assumed pinned.

The load P_{AB} is assumed unity and causes a relative deflection $\Delta_B = \frac{200}{2} = 100$. The deflection at B enables us to find the load at E by Greene's second theorem of area moments,

$$\Delta_B = 100 = \frac{1}{200}[(100P_{DE} \times 50 \times 166.7) - (200 \times 100 \times 133.3)]$$

Whence P_{DE} = 3.23

$$\Delta_E = \frac{1}{200}\{(3.23 \times 100 \times 50 \times 66.7) - 100[(100 \times 50) + (50 \times 66.7)]\} = 1{,}220$$

$\Delta_D = \Delta_E + \frac{3.23 \times 100}{10}$ = 1,252, as calculated from the system $ABEG$, and the member DE.

For such a deflection the stress in the hangar may be figured as follows: $\Delta_D = 1{,}252 = \frac{P_{CD} \times 100}{1}$, whence P_{CD} = 12.52. And for the beam DF, calling the end load Q_D, $\Delta_D = 1{,}252 = \frac{Q_D \times 100^3}{3 \times 100}$, whence Q_D = 0.38.

Adding the relative loads we have 1 + 3.23 + 12.52 + 0.38 = 17.13, and since the imposed load is 20 kips, we multiply by the ratio 20/17.13 and find P_{AB} = 1.17, P_{DE} = 3.77, P_{CD} = 14.62, and Q_D = 0.44.

The difference between these results and Mr. Laughlin's is due to the use of E = 30,000,000 in the member DE; the results show how little this change affects the loads, even when the shortening of DE is but a thirtieth of that in Mr. Laughlin's paper.

C. M. GOODRICH, M. Am. Soc. C.E.
Walkerville, Canada

TO THE EDITOR: It occurs to me that W. H. Laughlin, who contributed the article on "Solving a Frame of Multiple Redundancy by Method of Least Work," in the July number, may be interested in a little book by Isami Hiroi, entitled "The Statically Indeterminate Stresses in Frames Commonly Used for Bridges" (published in 1905 by D. Van Nostrand Company).

This volume is entirely devoted to the solution of all manner of structures by the method of least work—that is, the second theorem of Castigliano. It is a very remarkable volume but the labor of solution, judged by more modern methods, is often far from a minimum.

FRANCIS P. WITMER, M. Am. Soc. C.E.
Philadelphia, Pa.

Simplifying Earthwork Calculations

TO THE EDITOR: In the June issue of CIVIL ENGINEERING there is an article by F. F. Fergusson on "Earthwork Calculations Simplified," which consists of the determining of the algebraic sum of triangles by horizontal and vertical ordinates. The computation of areas by triangles is probably as old as the engineering and surveying profession. This is especially true with reference to the use of vertical and horizontal ordinates. A review of engineering literature will disclose that the subject appears periodically. It is probably desirable, however, to have it presented at regular intervals so that young men entering the profession will have it brought to their attention.

The chief purpose served by Mr. Fergusson's article is that it presents an orderly program for computing these areas. It may be recalled that on page 596 of the September 1940 issue the subject was fully presented, with a scheme for computations. The only merit claimed for the method was orderliness and simplicity. However, the scheme is adapted to the use of computing machines and has the advantage over that offered by Mr. Fergusson of requiring approximately one-half the number of computations.

JOHN S. WORLEY, M. Am. Soc. C.E.
Professor of Transportation Engineering, University of Michigan
Ann Arbor, Mich.

Reminiscences of an "Old Timer"

TO THE EDITOR: On reading the item on the "Oldest Members," in the July number, I was quite surprised to learn that I am Number 18 on the present list. Having reached the reminiscent age, my first thought was that members of our profession must die young. Later I recalled a poem by Burton Braly that started somewhat as follows,

"I flattered myself I had retained my youth."

But the end was a different story—

"When the girls' smiles say—as you have your fling—
'Oh, isn't he simply a spry old thing?'
Why, it should be plain (though it brings you pain)
That you've bidden your youth goodbye."

After graduating from the U.S. Naval Academy, I served two years in the Navy and resigned. Then came brief work on the old Queen and Crescent Railroad under L. G. F. Bouscaren, M. Am. Soc. C.E., and other jobs, and I started in with the Butte Water Company. Now I am in my fifty-first year with the company, as manager and chief engineer. In the meantime, vast changes in engineering practice have occurred. I am reminded of many difficulties in the past sixty years which have confronted the civil engineer—particularly those of us who came West, where a young man was given every chance to progress.

Butte is a relatively small community. However, the fact that the Anaconda mines surround the city and depend on the Butte Water Company for a large and safe supply necessitated the design of a system with a large capacity. In the days before electricity, when the miners used candles, fires below ground were of frequent occurrence, and we had to be in a position to furnish at all times a large and continuous supply of water.

Our first development, known as the "Basin Creek" supply, consists of a masonry dam, 100 ft high, 13 miles south of Butte. The dam was built with granite blocks, carefully set in rich cement beds, and the interstices were filled with concrete. The water face was constructed of hand-laid rubble, with tooled joints. I recall that we mixed all concrete by hand, selecting the sand from various pits in the vicinity, and testing only by rubbing between the palms of our hands for sharpness and dirt.

We imported portland cement from Germany for the foundation, using American portland above ground. At that time, there was lively discussion on the subject of concrete among engineers, some advocating wet concrete, others dry. As I was a supporter and admirer of Mr. Bouscaren, who was an extra-dry advocate, I followed his judgment and used dry concrete in this work. When I see the scientific concrete mixtures of today with washed sand, carefully selected aggregates, and carefully measured water, I look at Basin Creek Dam and wonder why it is in perfect condition after fifty years of service.

The design of the 24-in. influent pipe line presented another problem. Because of high freight rates cast-iron pipe was almost prohibitory, and we finally decided to use continuous stave redwood pipe on the theory that we could replace it in twenty years and save money. This pipe laid in 1892 is still in commission and, as far as I can judge, in perfect condition, which fact I attribute to its careful construction. Furthermore, maintenance is practically nominal.

Later we had other engineering problems. For instance, creating an additional water supply—by diverting from the head waters of the Missouri to the Columbia watershed and pumping across the Continental Divide—involved many knotty problems. Wooden pipe was also adopted on the new system; for pressures over 300 ft riveted steel is used. Regulating chambers along the hydraulic grade line prevent excessive pressure. These consist of a balanced valve, regulated by a float in an adjoining open chamber, with an overflow, so that if the valve is closed at the lower end the floats close the valves along the line, and in case they fail to work the overflows prevent excessive pressure on the pipeline.

A rope drive, driven by an 800-hp motor, connects to the plunger pumps, thus holding the steam end which is disconnected intact, as an auxiliary. This pump has been entirely satisfactory; it is still in regular service alongside a modern up-to-date centrifugal pump and develops better efficiency. The pumps are now all driven by electricity, and every part of the plant has been duplicated. Since fire engines are not used, we have to maintain fire pressure on all hydrants. The distribution system is divided into five separate parts, because Butte is built on the side of a mountain and has an 800-ft variation in elevation.

An interesting life has been my fate. Out of my experiences I would like to encourage the young men in our Society to look up in climbing the ladder of life, to assume responsibility when necessary, and to keep up in the procession. Such is the ambition that has kept us old civil engineers "humping" for the past sixty years.

EUGENE CARROLL, M. Am. Soc. C.E.
Vice-President and General Manager, Butte Water Company
Butte, Mont.

Ingenious Use of Arch Rib Centering

TO THE EDITOR: Mr. Serber's paper on "Integral Centering for Concrete Arch Ribs," in the August issue, has been read with much interest. He deserves great credit for introducing the steel arches into this construction, since the design of the structure did not originally contemplate this type of design and therefore did not provide details in that connection.

It is true that the design of a concrete arch rib with structural steel shapes as reinforcement is not a new idea. In fact, such an arch type was patented and the patent expired more than twenty-five years ago, if the writer's memory serves him, so there is truly nothing new in such an arch design. But it was not claimed by Mr. Serber that something new was discovered, only that an ingenious use was made of something old for the solution of a problem in hand.

The problem here was that of substituting for the design of a reinforced concrete arch rib, one in which the reinforcement consisted of the conventional reinforcing bars of required number and size and in which the structural steel shapes would act as reinforcement to carry the final load and, at the same time, support the forms of the concrete arch rib. The problem, therefore, was to adapt a design already completed to the falsework problem. The writer was retained for the purpose of developing this idea. It might be noted that the steel arch rib was designed to carry the load of the concrete rib only, including the forms, during construction, but not that of the slab spanning the space between the ribs. However, it was of sufficient section to provide the required area for carrying the total loads when completed. The problem included several "tricky" details, such as cantilever brackets that acted as supports for the substation floor and roof.

One of the interesting points in connection with the steel arch rib is the fact that the temperature effect on the deformation (deflection) was greater than that figured by the writer for the various conditions of "pouring."

M. HIRSCHTHAL, M. Am. Soc. C.E.
Hoboken, N.J.

Fall Meeting in Niagara Falls, Canada

Joint Meeting of the Engineering Institute of Canada and the American Society of Civil Engineers

THE GENERAL BROCK HOTEL TO BE HEADQUARTERS, OCTOBER 13, 14, 15, 1942

Registration, Opening Session, and Technical Meetings

WEDNESDAY—October 14—Morning

9:00 **Registration in the Main Lobby**

10:00 **Fall Meeting called to order in the Ballroom by**

WILLIAM T. HUBER, *President, Buffalo Section, American Society of Civil Engineers,* Buffalo, N.Y.

Addresses of welcome

10:10 C. G. CLINE, *Chairman, Niagara Peninsula Branch, Engineering Institute of Canada,* Niagara Falls, Canada.

10:17 C. R. YOUNG, *President, Engineering Institute of Canada.*

10:25 **Response by**

E. B. BLACK, *President, American Society of Civil Engineers.*

10:30 **Manpower Control as Related to Engineers**

ELLIOTT M. LITTLE, *Director, National Selective Service, Dominion of Canada,* Ottawa, Canada.

11:00 **Questions from the floor and general discussion**

11:15 **Engineers in the War and the Coming Peace**

ALEX TAUB, *Chief Engineer, Industrial Engineering Division, Board of Economic Warfare,* Washington, D.C.

11:45 **Questions from the floor and general discussion**

12:00 **Luncheon recess**

WEDNESDAY—October 14—Afternoon

SYMPOSIUM ON CIVILIAN PROTECTION IN WARTIME
(Closed Session)

2:30 p.m.—Ballroom

JOHN E. ARMSTRONG, *M.E.I.C., Chief Engineer, Canadian Pacific Railway Co.,* Montreal, Canada, *Chairman, Committee on Engineering Features of Civil Defence, Engineering Institute of Canada, Chairman of the Meeting*

ERNEST P. GOODRICH, *Director, Am. Soc. C.E., Chairman, National Committee on Civilian Protection in Wartime, American Society of Civil Engineers, Presiding*

This symposium has been prepared and is presented jointly by the National Committee on Civilian Protection in Wartime of the American Society of Civil Engineers and the Committee on Engineering Features of Civil Defence of the Engineering Intitute of Canada. This program is presented as a part of the contribution of the two participating organizations to give aid in protecting the lives and property of civilians. This is a **CLOSED SESSION.** Attendance is open to members of the two participating organizations who will pledge not to divulge the information presented to the detriment of the United States or the Dominion of Canada. The nature of the program precludes the attendance of reporters, non-citizens of either country, and non-members of either organization unless vouched for by the secretary of either organization.

Admission to this session will be by special card to be issued at the Registration Desk. These cards will be issued only to members (all grades) of the American Society of Civil Engineers, the Engineering Institute of Canada, and to those vouched for by the respective secretaries. Members will sign the cards at the Registration Desk and will again sign them in the presence of guards stationed at the door of the Ballroom. It is important that the second signature be not written prior to presentation. If the second signature is written prior to such time, admission will be refused. This session is a closed one by governmental request because of the confidential information to be discussed at the meeting.

2:00 **Introductory remarks on behalf of the American Society of Civil Engineers**

ERNEST P. GOODRICH, *M. Am. Soc. C.E., Consulting Engineer,* New York, N.Y.

2:05 **Introductory remarks on behalf of the Engineering Institute of Canada**

C. R. YOUNG, *President, Engineering Institute of Canada.*

2:10 **Structural Aspects of Civil Defense Work**

A summary of Confidential Lectures to a group of Canadian engineers, given by PROF. F. WEBSTER, *Deputy Chief Engineer, British Ministry of Home Security.*

To be presented by HARRY F. BENNETT, *M.E.I.C., District Engineer, Department of Public Works,* London, Canada; *Chairman of Special Subcommittee, Engineering Institute of Canada, Committee on Engineering Features of Civil Defence.*

3:00 **Discussion**

3:30 **Summary of the Work of the Committee on Engineering Features of Civil Defence, Engineering Institute of Canada**

ROBERT F. LEGGET, *M.E.I.C. and Assoc. M. Am. Soc. C.E., Assistant Professor, Department of Civil Engineering, University of Toronto,* Toronto, Canada.

3:50 **Discussion**

4:00 **The Relation of Local Engineer Committees with Official Governmental OCD and ARP Committees**

(*a*) **The Experience in the United States**

ERNEST P. GOODRICH, *Chairman, National Committee on Civilian Protection in Wartime, American Society of Civil Engineers.*

(*b*) **The Experience in Canada**

Speaker to be announced.

4:30 **Discussion**

5:00 **Adjournment**

WEDNESDAY LUNCHEON

12:30 p.m.—Ballroom

At the close of the Wednesday morning session, luncheon for registrants, including ladies and guests, will be served in the Ballroom of the General Brock Hotel.

C. R. YOUNG, *President, Engineering Institute of Canada, Dean, Faculty of Applied Science, University of Toronto,* will address the luncheon on

"THE PLACE OF THE ENGINEER"

Tickets for the luncheon are $1.10 each.

Sessions of Technical Divisions

THURSDAY—October 15—Morning

POWER DIVISION

Blue Room

OTTO HOLDEN, *M.E.I.C. and M. Am. Soc. C.E., Chief Hydraulic Engineer, Hydro Electric Power Commission of Ontario,* Toronto, Canada, *and* WILLIAM P. CREAGER, *Chairman, Executive Committee, Power Division, Presiding*

9:30 Address by

OTTO HOLDEN, *M.E.I.C. and M. Am. Soc. C.E., Chief Hydraulic Engineer, Hydro Electric Power Commission of Ontario,* Toronto, Canada

THE PRESERVATION OF NIAGARA FALLS

9:35 Part 1—The Problem in General

NORMAN MARR, *M.E.I.C., Chief Hydraulic Engineer, Dominion Water and Power Bureau, Surveys and Engineering Branch, Department of Mines and Resources,* Ottawa, Canada

10:00 Part 2—Hydraulic Aspects of the Problem

C. G. CLINE, *M.E.I.C., Senior Assistant Engineer, Dominion Water and Power Bureau, Surveys and Engineering Branch, Department of Mines and Resources,* Niagara Falls, Canada

Discussion by

10:15 M. T. GRAY, *O.L.S., General Manager, Niagara Parks Commission,* Niagara Falls, Canada.

10:25 A. B. COLE, *Secretary, Niagara Frontier State Park Commission,* Niagara Falls, N.Y.

10:35 E. B. STROWGER, *Chief Hydraulic Engineer, Niagara Falls Power Company,* Niagara Falls, N.Y.

10:50 Address by

WILLIAM P. CREAGER, *M. Am. Soc. C.E., Consulting Engineer,* Buffalo, N.Y.

10:55 Construction of Niagara River Submerged Weir

MAJ. HARLAND C. WOODS, *Corps of Engineers, U.S. Army, M. Am. Soc. C.E., U.S. Engineer Office,* Buffalo, N.Y.

11:20 Discussion by

DAVID FORGAN, *M.E.I.C., Construction Engineer, Hydro Electric Power Commission of Ontario,* Toronto, Canada

11:35 General discussion

12:00 Adjournment

THURSDAY LUNCHEON

12:30 p.m.—Ballroom

At the close of the Thursday morning sessions luncheon will be served in the Ballroom for members, ladies and guests.

Brig. Gen. Edwin H. Marks, U.S. Army, M. Am. Soc. C.E., Commanding Officer, Fort Belvoir, Va., will speak on

"BASIC TRAINING OF ENGINEER OFFICERS AND ENGINEER SOLDIERS"

Tickets for the luncheon are $1.10 each.

STRUCTURAL DIVISION

Rainbow Salon

A. ROSS ROBERTSON, *M.E.I.C., Manager, Ontario Division, Dominion Bridge Co., and* ALFRED HEDEFINE, *Member, Executive Committee, Presiding*

9:30 Introductory remarks

ALFRED HEDEFINE, *Assoc. M. Am. Soc. C.E., Associate Engineer, Waddell & Hardesty,* New York, N.Y.

9:40 Conservation of Critical Materials

MAJ. HIBBERT M. HILL, *Corps of Engineers, U.S. Army, Assoc. M. Am. Soc. C.E., Office, Chief of Engineers,* Washington, D.C.

10:15 Discussion

10:25 Method Employed in Moving Heavy Coal Bridge at Algoma Steel Corporation

DAVID C. TENNANT, *M.E.I.C. and M. Am. Soc. C.E., Engineer, Ontario Division, Dominion Bridge Co., Ltd.,* Toronto, Canada.

11:00 Discussion

11:10 Prefabricated and Laminated Timber Construction

VERNE L. KETCHUM, *M. Am. Soc. C.E., Chief Engineer, Timber Structures, Inc.,* Portland, Ore.; Member, Committee on Timber Structures, recently authorized committee of the Structural Division. See item on page 581 of this issue.

11:45 General discussion

12:00 Adjournment

AMERICAN FALLS FROM GOAT ISLAND

RAINBOW BRIDGE FROM OAKES PARK

General information regarding immigration and customs regulations of the United States and the Dominion of Canada will be found in a special article under "Society Affairs" on page 582 of this issue

Sessions of Technical Divisions (*Continued*)

THURSDAY—October 15—Afternoon

CONSTRUCTION DIVISION

Blue Room

J. B. STIRLING, *M.E.I.C., Vice-President and Director, E. G. M. Cape and Co., Montreal, Canada, and*

HARRY O. LOCHER, *Chairman, Executive Committee, Presiding*

2:00 Introductory remarks

HARRY O. LOCHER, *M. Am. Soc. C.E., Secretary-Treasurer, National Association of River and Harbor Contractors*, New York, N.Y.

2:10 Employer-Employee Relations in the Construction Field

CHESTER W. WRIGHT, *President, Wright and Kremers, Contractors*, Niagara Falls, N.Y.

2:50 Discussion

3:05 Employer-Employee Relations in Canadian War Construction Industry

DOUGLAS B. CHANT, *National Selective Service Board, Department of Labour*, Ottawa, Canada.

3:45 Discussion

4:00 Transit Shed with Concrete Roof Arches, Harbor of St. John, New Brunswick

FRANK E. STERNS, *M.E.I.C.* and *M. Am. Soc. C.E., Engineer, National Harbours Board*, Ottawa, Canada

4:40 General discussion

5:00 Adjournment

SURVEYING AND MAPPING DIVISION

American Room

WILLIAM N. BROWN, *Chairman, Executive Committee, Presiding*

2:00 Introductory remarks

WILLIAM N. BROWN, *M. Am. Soc. C.E., President, W. N. Brown, Inc.*, Washington, D.C.

2:10 Surveying on the Niagara Frontier

WILLIAM A. RATHMANN, *M. Am. Soc. C.E., Engineer, Nussbaumer and Clark, Consulting Engineers*, Buffalo, N.Y.

2:50 Discussion

3:05 Canadian Surveys and Maps in Peace and in War

FREDERIC H. PETERS, *M.E.I.C. and M. Am. Soc. C.E., Surveyor-General and Chief, Hydrographic Service, Department of Mines and Resources*, Ottawa, Canada.

3:45 Discussion

4:00 General discussion

4:30 Adjournment

HIGHWAY DIVISION

Rainbow Salon

CHARLES D. CURTISS, *Secretary, Executive Committee, Presiding*

2:00 Introductory remarks

CHARLES D. CURTISS, *M. Am. Soc. C.E., Chief, Division of Control, Public Roads Administration, Federal Works Agency*, Washington, D.C.

2:10 Flight Strips—Present and Future

FREDERICK E. SCHNEPPE, *Assoc. M. Am. Soc. C.E., Executive Assistant, Public Works Administration*, Washington, D.C.

2:40 Discussion

3:05 Wartime Concrete Pavement Design

LEON E. ANDREWS, *Assoc. M. Am. Soc. C.E., Regional Highway Engineer, Portland Cement Association*, New York, N.Y.

3:45 General discussion

4:15 Adjournment

THE GENERAL BROCK HOTEL, NIAGARA FALLS, ONTARIO, CANADA

VIEW OF THE FALLS FROM SUN DECK AND RAINBOW ROOM OF GENERAL BROCK HOTEL

The speakers on this program who have consented to be present at this Joint Meeting are making a direct, tangible contribution to aid engineers in helping our governments to win the war. Nevertheless, they have accepted invitations to speak contingent upon emergencies that may develop.

RAINBOW ARCH BRIDGE ACROSS NIAGARA RIVER BELOW THE FALLS

Local Sections Conference

TUESDAY—October 13—All Day

Rainbow Salon

WILLIAM M. SPANN, *Chairman, Committee on Local Sections, Am. Soc. C.E., Presiding*

The third Regional Local Sections Conference for 1942 will include 20 Local Sections of the Northeastern area of the United States. All interested members of the Society and the Institute are invited to attend and are urged to participate in the discussions. The official representatives will discuss the following subjects:

CIVILIAN PROTECTION ACTIVITIES OF LOCAL SECTIONS

EMPLOYER-EMPLOYEE RELATIONSHIPS IN THE ENGINEERING PROFESSION

LOCAL SECTION ACTIVITIES DURING WARTIME

Morning, 9:30–12:00

9:30 Address of welcome

WILLIAM T. HUBER, *President, Buffalo Section, American Society of Civil Engineers*, Buffalo, N.Y.

9:45 Introduction of Local Section representatives

WILLIAM M. SPANN, *M. Am. Soc. C.E., President, Tuttle-Ayers-Woodward Engineering Co.*, Kansas City, Mo.; *Chairman, Society's Committee on Local Sections.*

9:50 CIVILIAN PROTECTION ACTIVITIES OF LOCAL SECTIONS

ERNEST P. GOODRICH, *Chairman, National Committee on Civilian Protection in Wartime, American Society of Civil Engineers*, will present a brief outline of the type of work in which Local Sections are expected to participate, and will describe the work undertaken by some local committees.

10:15 Response by each Local Section representative

12:00 Adjournment for group picture and luncheon

TUESDAY LUNCHEON

12:30 p.m.—Ballroom

Local Section representatives will join members of the Society's Board of Direction and officers of the Engineering Institute of Canada and others who have already registered for the meeting, at luncheon in the Ballroom.

Tickets for the luncheon are $1.10 each.

Afternoon, 2:00–5:00

2:00 EMPLOYER-EMPLOYEE RELATIONSHIPS IN THE ENGINEERING PROFESSION

HOWARD F. PECKWORTH, *Assistant to the Secretary, American Society of Civil Engineers*, New York, N.Y.

3:00 Report by a Member of the Committee on Salaries of Engineers, Engineering Institute of Canada

3:20 Response and discussion by each Local Section Representative

4:00 LOCAL SECTION ACTIVITIES DURING WARTIME

The balance of the afternoon will be devoted to a general open discussion of Local Section activities and affairs during wartime.

5:30 Adjournment

INFORMAL DINNER

TUESDAY—October 13—6:30 p.m.

Ballroom

On Tuesday evening there will be an informal dinner for the officers and directors of The Engineering Institute of Canada and the American Society of Civil Engineers, all Local Section delegates, and all members of the Institute and the Society, and ladies who have already arrived for the meeting.

Dinner will be served following a social hour to provide opportunity for everyone to become happily acquainted which is the primary purpose of this informal occasion.

No speeches.

Tickets for the dinner are $1.75 each.

Hotel Accommodations and Announcements

Hotel Rates

The General Brock Hotel, located at the Canadian end of the recently constructed Rainbow Arch Bridge, is Hotel Headquarters for the Fall Meeting.

All registration, luncheons, dinners, and technical meetings will be held in the hotel, which is easily reached by a 15-minute taxi ride from the New York Central Railroad Station in Niagara Falls, N.Y. In the schedule of rates which appears below, the rooms designated as "front" all have a splendid view of the Falls.

The Fox Head, a smaller hotel, is located about one block from the General Brock, and although the Headquarters Hotel is completely reserved for the Fall Meeting, rooms will be available at the Fox Head Hotel in case of overcrowding of the General Brock. Rates at the Fox Head Hotel are comparable to those at the General Brock Hotel.

Advance Reservations

To be certain of hotel accommodations, members are urged to make reservations in advance of the meeting date with Mr. Ronald P. Peck, Manager of the General Brock Hotel.

Everyone attending the Fall Meeting is expected to register in the Main Lobby of the General Brock Hotel.

	FRONT	REAR
Single rooms	$3.50 & 4.00	$3.00
Double rooms	6.00 & 7.00	5.00
(All rooms are with bath.)	(Double or twin beds)	(Double beds only)

Bridge and Tea for the Ladies

WEDNESDAY—October 14—3:00 to 5:00 p.m.

Rainbow Room

All visiting ladies are invited to a bridge and tea to be given in their honor by the Management of the General Brock Hotel.

Visiting ladies will be received in the Rainbow Room on the tenth floor of the General Brock Hotel, by the Ladies' Reception Committees of the Niagara Peninsula Branch of the Engineering Institute of Canada, and the Buffalo Section of the American Society of Civil Engineers.

The Rainbow Room affords a delightful view of both the American and Canadian Falls and a most enjoyable afternoon is assured.

Tickets, badges, and closed-session admission cards will be obtained at the time of registration.

Information

An Information Desk will be provided in the main lobby of the General Brock Hotel to assist visiting members and to furnish information about the meeting and points of interest in and about Niagara Falls, Canada.

Train travel to Niagara Falls, Canada, is convenient and accommodations are ample.

Since the General Brock Hotel is only a short taxi ride from the New York Central Depot at Niagara Falls, N.Y., it is suggested that Niagara Falls, N.Y., be considered the destination in purchasing rail transportation.

Members are urged to make departure reservations either prior to or immediately after arriving at the meeting.

This program has been prepared under the direction of the Fall Meeting Committee composed of CHARLES B. BURDICK, *Vice-President, Am. Soc. C.E., Chairman;* WILLIAM N. CAREY, JOHN W. COWPER, WILLIAM D. DICKINSON, ERNEST E. HOWARD, GEORGE B. MASSEY, and R. B. WILEY, *Directors, Am. Soc. C.E.*

THE ENGINEERING INSTITUTE OF CANADA

Officers and Directors of the Niagara Peninsula Branch

C. G. CLINE, *Chairman*
G. E. GRIFFITHS, *Vice-Chairman*

A. G. HERR, W. D. BRACKEN, R. T. SAWLE, J. W. BROOKS, G. F. VOLLMER, J. H. TUCK, D. S. SCRYMGEOUR — *Executive*

A. L. MCPHAIL, *Past-Chairman*; A. W. F. MCQUEEN, *Councillor* — *Ex-officio*

J. H. INGS, *Secretary-Treasurer*

Men's Reception Committee

C. G. CLINE, *Chairman* G. E. GRIFFITHS A. L. MCPHAIL

Ladies' Reception Committee

MRS. A. W. F. MCQUEEN, *Chairman*

MRS. W. D. BRACKEN, MRS. C. G. CLINE, MRS. J. W. BROOKS, MRS. J. H. INGS

AMERICAN SOCIETY OF CIVIL ENGINEERS

Officers and Directors of the Buffalo Section

W. T. HUBER, *President*
N. M. HERTHE, *Vice-President*
N. L. NUSSBAUMER, *Treasurer*
C. R. VELZY, *Secretary*
W. B. CARR NELSON STONE

Men's Reception Committee

J. W. COWPER, *Chairman*

W. B. CARR	E. P. LUPFER	NELSON STONE
N. M. HERTHE	G. S. MINNISS	G. E. SYMONS
W. T. HUBER	N. L. NUSSBAUMER	GEORGE UNGER
W. C. KELLY	H. E. RIEXINGER	C. R. VELZY

Ladies' Reception Committee

MRS. J. W. COWPER, *Honorary Chairman*
MRS. E. P. LUPFER, *Honorary Vice-Chairman*
MRS. NELSON STONE, *Chairman*
MRS. N. M. HERTHE, *Vice-Chairman*

MRS. W. B. CARR	MRS. N. L. NUSSBAUMER
MRS. W. P. CREAGER	MRS. H. E. RIEXINGER
MRS. W. T. HUBER	MRS. G. E. SYMONS
MRS. W. C. KELLY	MRS. GEORGE UNGER

MRS. C. R. VELZY

FORMAL DINNER AND ADDRESS

WEDNESDAY—October 14—7:00 p.m.

Ballroom

C. G. CLINE, *Chairman, Niagara Peninsula Branch, Engineering Institute of Canada, Presiding*
DR. H. J. CODY, *President, University of Toronto,* will speak on

"WE ARE IN IT TOGETHER IN THE DEFENSE OF CIVILIZATION"

A surprise feature of entertainment will be announced at the close of the dinner. This will be followed by dancing beginning at 9:30 p.m.

Tickets are $3.00 for members and men guests, and $2.00 for their ladies. Special tickets for Juniors are $2.00, and for their ladies, $1.50.

Dress—Formal or Informal.

SOCIETY AFFAIRS

Official and Semi-Official

CIVIL ENGINEERING'S Twelfth Birthday

TWELVE YEARS AGO, on October 1, 1930, the first issue of CIVIL ENGINEERING appeared. The Committee on Publications proposed the creation of this added service to the membership so as to make available an authentic record of Society progress and so that new ideas in the civil engineering field might be presented vigorously through a Society-sponsored medium. The value of the 144 issues can best be judged by considering the monumental works, the achievements in research, design, and construction, that have been explained and discussed in the more than 1,500 main articles published to date.

These articles represent a cross section of the civil engineering field, from the mechanics of a penetration needle for testing soil compaction to the construction of the world's greatest structure. Coverage as broad as that of the ever-expanding profession itself has been maintained through the interest of many authors—engineers who have given their time and talent to their confreres through the medium of CIVIL ENGINEERING. These men, whether they have told about a minor device or about a mammoth edifice, have recorded this progress for the benefit of the thousands of readers of this publication.

As a result of this professional interest of engineers, each issue has contained subjects designed to appeal to a variety of tastes. A makeup board in the editorial offices indicates the scope of each issue. Each article is represented by a tag placed in the proper position on the board, which is divided into some 50 classifications, covering the entire field. Everything from foundations to flag poles, and from flood control to flying fields, finds its proper place not only as regards subject but also as regards time of publication. The distribution of these tags on the board indicates the activity of authors in the respective fields.

Many of the articles are adapted from papers or addresses delivered before Society meetings—local and national. The four quarterly meetings of the Society are generously represented, and by this means CIVIL ENGINEERING is able to present a technical report of such meetings for the benefit of members who have not themselves been able to attend. Numerous other articles are taken from the programs of the Local Sections. Whatever the source of these papers, their publication makes available the best of the engineering thought and research brought to light through Society activities.

STRUCTURES DESCRIBED IN "CIVIL ENGINEERING" ILLUSTRATE TWELVE YEARS OF PROGRESS IN DESIGN AND CONSTRUCTION
(1) Reinforced Concrete Spans of Arch Viaduct, (2) Trylon and Perisphere at New York's World's Fair, (3) City Hall, Kansas City, Mo., (4) World's Tallest Structure, New York's Empire State Building, (5) Filter Gallery in Detroit Water Treatment Plant, (6) Pennsylvania Turnpike at Night, (7) Recent Concrete Dam in Process of Construction

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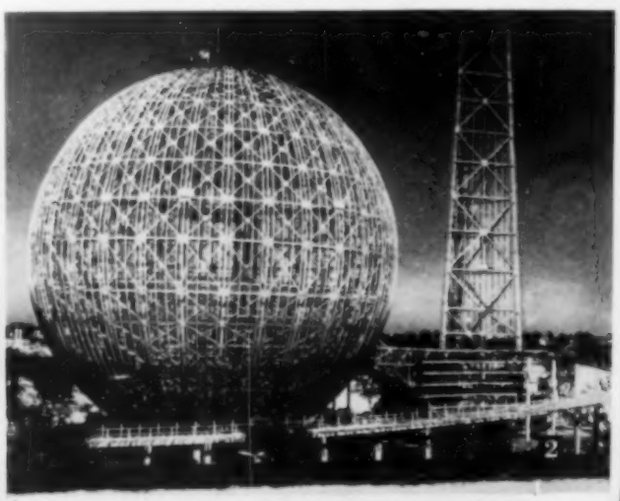
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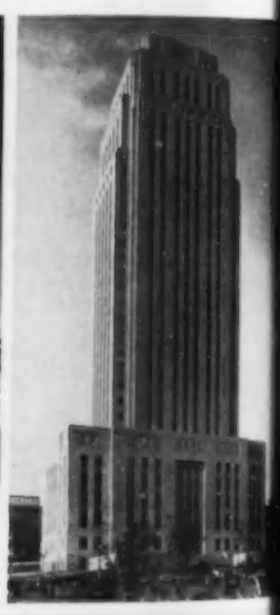

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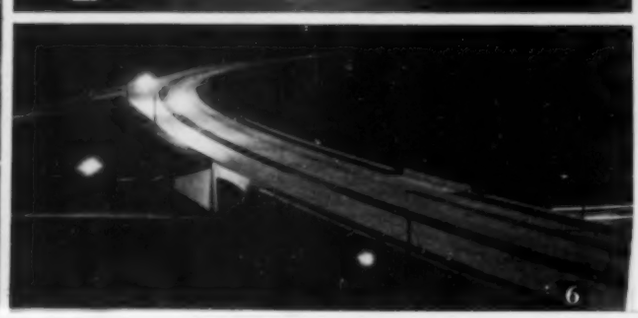
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At times the men in charge of projects of outstanding importance are so wrapped up in their work that they do not permit themselves the luxury, or drudgery, of writing. Then it becomes necessary to call the privilege of authorship to their attention. Authors are unanimous in stating that they themselves are the greatest gainers from the task of describing their work on paper. The satisfaction of having the record in print more than compensates for the labor of composition.

Usually each issue contains ten to twelve main articles and a dozen shorter contributions or comments. Supplementing this technical material there are another two dozen items on Society matters, professional interests, and records of progress. Hundreds of reports—on Student Chapters, Local Sections, news of members, obituaries, and similar matters—are given each year. The total, including advertising, has consistently averaged about 100 pages per month. The edition printed, however, has shown an expansion in keeping with the Society's growth; about 19,000 copies are now printed each month as compared with 16,000 twelve years ago.

The united engineering effort to strengthen America began long before Pearl Harbor. In like manner all-out war found CIVIL ENGINEERING already devoting the majority of its pages to carrying forward the preparedness program so vigorously supported by the Society. As President Black said in a recent address, "What we need is speed in all of today's engineering activities—and we cannot have action until we know where we are going. It is the Society's purpose to point out that course to you."

Increasing care is being taken to avoid printing any technical information, text or illustration, that may be used by an enemy to impede our war effort. Active assistance in this matter is being given by the Public Relations Bureau of the War Department. It is their task, and a difficult one too, to determine the choice of both articles and illustrations for publication at home and abroad. Even though a report may lose timeliness by delayed publication, care must be exercised to withhold any information that might be used detrimentally.

Coming months are potentially rich in the development of new designs, new materials, new equipment, and in the new and more efficient administration of projects both public and private. The virility of our profession is demonstrated by the part it is playing in this emergency. In recording that part, CIVIL ENGINEERING can and must render every possible service. Author and reader can both find here a medium for the development of their personal capacities to the greatest benefit of the nation they serve.

This birthday of CIVIL ENGINEERING is a milestone which marks the publication of 14,000 pages of papers, Society news, and advertising. But it does more than that—it also points unequivocally to the future, to greater opportunity and greater service.

Further Results from Society's War Registry

Additional Replies to Questionnaire Permit Interesting Conclusions

THREE matters of interest have been revealed by the replies to the recent postcard questionnaire sent to all members. How many members of the Society are now in the Army or the Navy and what ranks do they hold? How many now in the armed services are Juniors of the Society? And how many civilian members are likely to be available for reemployment when war construction in this country ceases?

THOSE IN THE ARMED SERVICES

First, however, a comparison should be made between the major factors derived from the first 10,301 replies received up to August 18 last (and reported in the September issue of CIVIL ENGINEERING, page 529) and those received up to September 15. In that interval just 25% more replies were received, making a total to date of 12,895, or 73% of the total number issued. On the earlier date 14% were reported in the Army or the Navy. Now the percentage is 16.66. Then 45% reported themselves as engaged on war projects or industries. Now that percentage is 45.6. Then 13% stated that they were engaged on official activities growing out of the war. Now this percentage is 12.2. As for those answering "No" to all three questions, the percentage then was 28%, and now it is 25.5%

Then it appeared that probably 2,510 of the Society's members were in uniform. Now the figure is so close to 3,000 that it may be assumed to be in excess of that number, that is, more than 1 for every 6 members. No replies have been received from overseas, but 217 members are reported in this category by relatives or former business associates. The percentage of those with commissions remains exactly as before—94%.

Of those in uniform, 73% are in the Army and 27% in the Navy. In the Army 6.8% have gradings lower than that of 2nd Lieutenant; 15.9% are 2nd Lieutenants; 26.2% are 1st Lieutenants; 24.1% are Captains; and 27.0% hold higher ranks up to and including that of Lieutenant General. In the Navy 4.7% have gradings lower than that of Ensign: 24.6% are Ensigns; 17.9% are Lieutenants (jg); 30.0% are Lieutenants; and 22.8% hold higher ranks up to and including that of Rear Admiral.

Of those in the Army 58.6% are in the Engineer Corps; 8.8% are in the Air Corps; and 32.6% are in other branches. Of those in the Navy, 52.3% are in the Civil Engineer Corps, and 47.7% report themselves as in other branches.

DISTRIBUTION OF JUNIORS IN THE ARMED FORCES

Of those in the Army, 53.4% are Juniors. Of those in the Navy, 51.3% are Juniors. The percentages of Society members in the various ranks who are Juniors are shown by the following table:

ARMY		NAVY	
Above rank of Captain	5.7%	Above rank of Lieutenant	0.0%
Captains	45.0%	Lieutenants	30.1%
1st Lieutenants	78.6%	Lieutenants (jg)	75.9%
2nd Lieutenants	88.0%	Ensigns	99.1%
Below rank of 2nd Lts.	91.1%	Below rank of Ensign	91.3%

Captains in the Army and Lieutenants (senior grade) in the Navy have the same base pay. Of those in the service, 26% hold those ranks. Of these, 40% are Juniors. Another 26% hold ranks higher than that of Captain (Army) and Lieutenant (Navy). Of these, 4.0% are Juniors. Of the remaining 48%, Juniors constitute 83%.

REEMPLOYMENT POSSIBILITIES

Intimate study of the details reported with respect to source of employment, titles held, and type of work performed on war projects and industries, permits the conclusion that many will be available for re-allocation or may experience unemployment when war construction in this country ceases. To what degree it will cease, and when, cannot of course be determined from the questionnaire.

The percentage given previously for those in this type of work (45.6%) would indicate a large number, but upon close examination it was observed that many are in such positions that they are likely to return to their normal work, or at least will not become unemployed. Some reported themselves as working for the railroads, for power companies, or for steel fabricating or coal producing companies. Others were associated with compani purveying materials such as lumber, cement, roofing, etc. Apparently, for the purpose of determining possible unemployment, or availability for re-allocation, or for entrance into the armed forces, these may be eliminated for the present.

Others reported themselves to be civilian employees of the Corps of Engineers of the Army, the Civil Engineer Corps of the Navy, the TVA, the RFC, the FWA, the Bureau of Reclamation, and other long-established federal departments. These also, it appears, are not likely to be unemployed or generally available for re-allocation. However, it does appear that about 4,500 members of the Society will have no definite employment in sight when and if work on the construction of war projects and industrial developments in the United States is completed.

New Committee of Structural Division Formed

AT THE Annual Convention of the Society held in Minneapolis, Minn., in July 1942, the Board of Direction, upon the recommendation of the Committee on Division Activities, authorized the formation of a Committee on Timber Structures as a new committee of the Structural Division. The personnel of this committee is as follows: Prof. R. J. Hansen, chairman, Col. William G. Atwood, Francis J. Hanrahan, Verne L. Ketchum, Ralph H. Mann, John A. Newlin, Prof. William A. Oliver, Herman Von Schrenk, C. H. Sandberg, and John J. Gould.

Immigration and Customs Information

For Those Crossing Into Canada to Attend Society's Fall Meeting

As many American tourists and business men have found during the first ten months of war, there has been little difficulty or delay in passing through Customs and Immigration between the United States and Canada. It should be pointed out, however, that more difficulty is often encountered in returning to the United States than in leaving it. For those who plan to attend the Fall Meeting at Niagara Falls, Ontario, Canada, available facts pertaining to the operation and requirements of the Immigration and Customs departments of both countries are given here.

IMMIGRATION

Inquiries at the U.S. Immigration Offices at Niagara Falls, N.Y., regarding exit from, and re-entry into, the United States indicate that:

1. Citizens born in the United States are not required to offer documentary evidence or proof, but merely to state to immigration officers at the border, the place of residence and place of birth.
2. Naturalized citizens of foreign birth should carry naturalization papers.
3. Those who are foreign-born of friendly countries and are not yet naturalized, should obtain and present at immigration a "Border Crossing Identification Card." These may be obtained free of charge from the Immigration Office nearest the home of the individual. Application must be made on Form I-189, which will be furnished to applicant by the Immigration Service. It is pointed out that applicants will be required to offer (*a*) Alien Registration Card, (*b*) evidence of legal admission to the United States for permanent residence, and (*c*) three 2 by 2-in. full-face photographs on a light background, printed on thin photoprint paper. This procedure requires several days and those for whom it is necessary should proceed immediately if planning to attend the Fall Meeting.
4. Those who obtained citizenship by naturalization of parents, should carry the naturalization papers of their parents and documentary evidence showing their relationship. A person of foreign birth who reached his majority prior to the naturalization of his parents is not a citizen of the United States by reason of such naturalization of parents.
5. Foreign-born women whose husbands have obtained citizenship since September 22, 1922, are not citizens of the United States by reason of such naturalization of their husbands regardless of date of marriage.
6. Residents of the United States who are not citizens and are nationals of Axis powers cannot leave or re-enter the United States.
7. Residents of the United States who are subject to draft must receive from their local draft board permission to leave the United States.

From the Canadian immigration officials, we learned that any person meeting the requirements of the United States immigration officials will have no difficulty in entering or leaving Canada. Any resident of the United States who is not a citizen will have to show his "Border Crossing Identification Card," proving his legal residence in the United States.

It is advisable that everyone have with him some reasonable identification such as automobile driver's license, automobile registration, business cards, letters, hotel credit cards, or any of the usual identification items one would have on one's person.

CUSTOMS

Detailed information regarding the United States customs may be obtained by writing to the Hon. William R. Johnson, Commissioner of Customs, Washington, D.C., requesting a copy of Customs Form 6061-B entitled, "Customs Hints for Tourists Entering the United States from Canada or Mexico." Briefly however, the following regulations should be noted respecting purchases in Canada:

1. All articles purchased in Canada are subject to duty if the purchaser has been outside of the territorial limits of the United States for less than 48 hours.
2. There is an exemption of $100 in value of articles acquired in Canada if the purchaser has been outside of the United States for 48 hours or more, such an exemption, however, to include not more than 100 cigars or 1 wine gallon of alcoholic beverages. This exemption is allowed each member of a family present.
3. There is no restriction upon cameras being taken into Canada or carried back into the United States. However, at the United States port of entry, all exposed film which has not been developed will be taken by the Customs and held for examination. The officials will take the name and address of the owner and after the films have been developed and printed and submitted to censorship, the owner will be notified of the cost of developing and printing, whereupon film and prints will be forwarded upon receipt of funds to cover such costs.

Those who desire to take foreign-made cameras or binoculars out of the United States should register them at the Customs Office at the port of exit. This will eliminate any questions as to the payment of duty upon them when returning to the United States.

The Canadian officials advised that there is no duty on usual personal articles carried by tourists. This does not apply, however, to any merchandise or articles intended for other persons or for sale. Furthermore, duty exemption is limited to 50 cigars, 200 cigarettes, 2 lb of manufactured tobacco, and 1 quart of alcoholic beverages.

Those who drive into Canada in automobiles and plan to be in Canada for less than 48 hours will be required to surrender their automobile licenses at the port of entry unless they plan to leave at another port, in which case they will be given a "Customs Auto Permit" for which no charge is made. Such a permit will also be issued to those who plan to stay in Canada more than 48 hours.

Gasoline is rationed in Canada but a tourist will be allowed a ration of 16 Imperial gallons (20 United States gallons), for which a coupon book will be issued at port of entry. Such a coupon book will be issued to an automobile owner only once in a 12-month period.

There is no restriction against cameras being taken into Canada nor is the use of them restricted except that no photographs may be taken of defended ports and areas or any defense project.

CURRENCY AND RATE OF EXCHANGE

Visitors to Canada may bring in with them any amount of currency and may take out with them any unspent portion. United States money will be accepted in Canada in payment of all debts, and all merchants, hotel keepers, and banks are required by law to pay the official premium set by the Foreign Exchange Control Board, which at present is 10%. For example, if a $5 bill of United States currency is offered in payment of an article costing $1, the purchaser will be given $4.50 in change in Canadian money. The General Brock Hotel, Society Headquarters for the Fall Meeting, will exchange all Canadian money for United States currency upon departure of guest at the same rate of exchange, that is, $1 in United States currency for every $1.10 in Canadian currency. Please note that all prices of tickets for functions at the Fall Meeting are expressed in terms of Canadian currency and therefore are about 9% less than if expressed in terms of United States currency.

Society Activities in This Issue

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U.S. Corps of Engineers in Peace and War

Script of a Radio Program in the Series, "The Engineer at War"

Many of our Society members are active as officers or civilian employees of the Corps of Engineers, U.S. Army. And other engineers are fairly familiar with their duties and accomplishments. But not so civilians—and it was particularly for such an audience that WEAF devoted a half-hour on Thursday evening, September 17, to the following interesting program. This is one of a series presented on that night each week over WEAF from 6:30 to 7:00 p.m.

The principal narrators, General Reybold and General Robins, are members of the Society.

ANNOUNCER: The Engineers at War!

Sound: Pneumatic drill—riveting—construction noises in and out.

VOICE NO. 1: I tell you, Jack, it was something to see! When I went out to the camp I was expecting something like the slapboard barracks we had back in '17. But, no—the camp was shipshape—clean as a whistle—a real, going, modern city.

VOICE NO. 2: Amazing how they do it. We haven't been in this war much over nine months yet.

VOICE NO. 1: Yes, it must have taken a lot of work and planning to house our millions of soldiers in such a hurry.

VOICE NO. 2: Well, tell me this—who builds these camps? Seems like some outfit has been doing a swell job with a minimum of ballyhoo.

VOICE NO. 1: I suppose the Army builds 'em—no—no, wait—they use regular labor—I s'pose civilians do it.

VOICE NO. 2: I think you were right the first time—it's the Army Engineers.

VOICE NO. 1: No—they just build bridges and forts. I guess it's—well—gosh, I don't know who builds 'em! I wish I did.

ANNOUNCER: Then just keep listening—for "The Engineer at War" has your answer. This is the tenth of the series, "The Engineer at War," a public service feature presented with the cooperation of some of the leading engineering societies of the country and the Office of Civilian Defense. Our topic tonight is "The United States Corps of Engineers in Peace and War" and our two guests are Maj. Gen. Eugene Reybold, Chief of Engineers, U.S. Army, and Maj. Gen. T. M. Robins, Assistant Chief of Engineers in Charge of Construction, U.S. Army. General Reybold, the question at the moment seems to be centered around the question: Who builds the Army camps? What's the answer?

MAJ. GEN. EUGENE REYBOLD, M. AM. SOC. C.E., CHIEF OF ENGINEERS

GEN. REYBOLD: The answer is the Corps of Engineers.

ANNOUNCER: Am I correct then in assuming that the Corps of Engineers is a construction agency?

GEN. REYBOLD: It is a construction agency all right; but it is much more than that. It is a component part of the new Army of the United States, the greatest All-American team ever assembled. As a component part of that great team, the Corps of Engineers has many responsibilities. Construction of camps and other facilities is one of them. Among the others are many operations carried on under combat conditions, in the very teeth of enemy fire

ANNOUNCER: I see that our subject tonight is to be even more interesting than I had supposed. With such a versatile organization for our subject, we must begin somewhere. Suppose we settle first the little argument which Jack and his friend were having as our program came on the air. To get the ball rolling, let me say that I have heard somewhere that our War Construction Program is the biggest construction program in history. Is that true, General Reybold?

GEN. REYBOLD: Well, I would not be surprised but what that is true; but, the mere size of the program is not the important thing. What do you think, General Robins?

GEN. ROBINS: The important thing is that we have given our growing young army the housing it needs—and we have given it on time.

ANNOUNCER: That's a very significant statement, General. I know what it means when you say you have delivered the goods "on time." In war, anything that is late may be worse than useless. I know, too, that the simple statement that you have provided housing for the Army gives little indication of the magnitude and complexity of the job. Can you say something further on this, General?

GEN. ROBINS: It may interest you to know that in the past year and a half, we have moved more dirt in our construction program than was moved in digging the Panama Canal; we have built enough buildings to house the population of Philadelphia; and we have acquired enough land to make up a good-sized state—say, West Virginia. But these astronomical figures perhaps are not the best way of answering your question. Perhaps the best thing I can do is to give you a general idea of what it means to provide housing for an Army cantonment caring for say 35,000 troops. Such a cantonment would normally include one, and perhaps two, infantry divisions.

ANNOUNCER: Excellent, General. By now most of us know that an Army is composed of many "Divisions," and that each Division includes something like 15,000 officers and men. To provide housing for even a single Division, which I gather, occupies approximately half of the buildings of a large cantonment, must be a formidable job.

GEN. ROBINS: Well, "formidable" is quite a word. If you consider building a complete city for 35,000 people within six months "formidable"—well—that's the word for it. In an average case, we would lay down and build perhaps 50 miles of road. We would install almost that many miles of sewer lines. We would provide a water purification plant, a sewage disposal plant, and perhaps an electric lighting plant. Then, of course, we would build the barracks buildings, the messhalls, the bathhouses, and many other facilities. Altogether, we would erect somewhat more than 2,000 buildings for this 35,000 troop city. In the course of our construction we might extend a railway line into the area, and nearby we might provide a landing field for aircraft.

ANNOUNCER: I think the word "formidable" is too mild. When we stop to consider that many camps such as the one you have described have been built over the entire country, we begin to get an idea of the size and importance of your construction program.

GEN. ROBINS: Of course, you understand that the housing of troops forms only one part of our construction program. We have built and are building many other things. We are building factories for the manufacture of airplanes, depots for the storage of powder, schools for the instruction of young pilots, bases from which our overseas forces can operate, highways and landing fields—Oh, the list is a long one. Altogether, our construction forces total not far short of one million men.

ANNOUNCER: General Reybold, to have accomplished things such as these you must have a most efficient organization.

GEN. REYBOLD: Well, we have an organization based squarely on the one which the Corps of Engineers has built up through a hundred years of peacetime work on the rivers and harbors of America. It is a nation-wide organization and it functions on the principle of decentralization. That is, we have the country divided into "Engineer Districts" and "Engineer Divisions." Our time-tested way is to select our district and division engineers with care, to give them a job, and to let them go to it.

ANNOUNCER: That system is the very antithesis of red tape. America indeed is fortunate that its wartime construction has fallen into the hands of Engineers who have behind them the heritage of such accomplishments as the construction of the Panama Canal and the control of Mississippi River floods.

GEN. ROBINS: You understand, of course, that our Engineer offices employing civilian engineers and architects plan the work

and supervise the actual construction. However, the construction itself is accomplished chiefly by contractors. That is the democratic way of doing things. One of America's great assets in this total war is our strong contracting industry.

ANNOUNCER: Of course, anyone who gives it a moment's thought knows that this construction work about which we are talking is at the very foundation of the war effort. I am afraid, however, that the direct connection between construction at home and the war abroad is not often brought to the attention of Mr. Average American.

REYBOLD: You are probably right; but, every once in a while something happens to emphasize dramatically the fundamental importance of our construction work. I recall a few months ago visiting a Western city. The occasion was the completion of a great bomber assembly plant. General Robins and his forces had finished the plant exactly one year after the first ground had been broken. In that single year the plant had been designed, the plans and specifications drawn up, the contracts let, the tools and equipment purchased, and the construction itself completed. As I watched the first 4-motor bomber roll off that assembly line, it seemed that the reverses of the first few months of war emerged in clear perspective. I knew that any nation which could do what had there been done in a few months must in the end be invincible. Already the events symbolized in the opening of that first plant are coming to pass in the raids over such German cities as Duesseldorf and Hamburg.

BRIG. GEN. THOMAS K. ROBINS, M. AM. SOC. C.E., ASSISTANT CHIEF OF ENGINEERS

ANNOUNCER: Yes, and that raid over Tokyo and Kobe was further explosive evidence of what you mean. But, General, do I understand that all engineer construction work is of the type we have been discussing? In other words, doesn't our Army have engineer troop units, and do they not also engage in construction?

REYBOLD: Our Army does, indeed, have engineer troop units and they do, indeed, perform construction work—

ROBINS: That is, they perform construction work when they are not fighting. I am sure that you noted the press account a few days ago which told how an engineer battalion, engaged in building an air field on an island in the Southwestern Pacific, laid down its tools and equipment and took up its rifles and machine guns long enough to repel a Japanese landing attack.

REYBOLD: Yes! General Robins, that little incident illustrates well the spirit of our engineer troops. They are able and willing to do anything required of them.

ANNOUNCER: I think another example of that spirit is found in the military highway which is being constructed through Canada to Alaska. Are not your engineer troops concerned in the project, General?

REYBOLD: Yes, the Canada-Alaska Military Highway—or the "Alcan" Road as we call it—is being built by engineer regiments. I should say that it is being completed by engineer regiments. Those regiments went into the wilderness through which the road is being built early in May. At that time, the country up there was still in the grip of winter. There were instances where the engineer soldiers marched overland to get to their starting points through temperatures reaching 40 below. The hardships were many and great; but construction of the 1,600 mile road is proceeding at a rapid pace.

ANNOUNCER: That is wonderful, General, and it is also a striking answer to those who said that such a road could not be built. Now, I wonder if we can go a bit further on this subject of engineer troop units in the war itself. The example of the Engineer soldiers setting the Japs back on their heels on that Pacific Island makes me curious to hear more of the same. What further can you tell us, General?

REYBOLD: Well, it has been said that modern war is an Engineer's war. Of course, that is not strictly so, for the Infantry and Air Forces and all other Arms and Services must operate as a team. But, it is a fact that modern war has placed a premium on speed and mobility. And it is also a fact that an Army's ability to move fast depends greatly on its engineers.

ANNOUNCER: I am not sure that I follow you, General. Can you explain a little further?

REYBOLD: Yes, the Engineer enables the Army to move fast by removing from its path the obstacles which otherwise might prove impassable. For example, a river is a major military obstacle—but our Engineer troops remove it as an obstacle by putting across it their pontoon bridges.

ROBINS: Another example might be fortifications. Even under modern conditions fortifications can be great obstacles—as is currently being shown at a place called Stalingrad. It is up to the engineer to assist the Army in overcoming fortifications. This the engineers do by methods of close assault. They get right up against the enemy fortifications and literally blow them out of existence with T.N.T.

REYBOLD: I am glad to hear you mention T.N.T., General, for it is the characteristic engineer material. Our troops use it not only offensively in the way you have described, but they also use it to demolish bridges and other structures in order to impede the advance of the enemy. T.N.T. comes close to being the engineer's best friend.

ANNOUNCER: General, what is the engineer soldier doing when he is not building a road through the wilderness, or blowing up an enemy fortification, or demolishing a critical enemy bridge?

REYBOLD: He may be doing any of dozens of things. He may be supplying water to the thirsty doughboys, he may be turning out maps for the impatient artilleryman, he may be operating a railway or a saw mill, he may be camouflaging an air field so that it looks like an apple orchard—

ROBINS: Yes, and if worse comes to worst, he may be doing like those boys on that island: grabbing a rifle and fighting shoulder to shoulder with the Infantry.

ANNOUNCER: Indeed, General Reybold—you have given us a vivid picture of an alert Corps of Engineers which has already met the challenge of new conditions and will continue to meet the ever-changing contingencies of an all-out war against a powerful enemy. I think the pride you have expressed in the Corps of Engineers can be shared by our entire nation—a pride and an assurance that we have the men, the equipment, the intelligence, the training and the will to win. We know our Army Engineers will help us build the road to Victory. Thank you General Robins—thank you, General Reybold!

Study of Cavitation Under Way

A NEW hydraulic research project has been authorized—a study of cavitation in hydraulic structures. This work has now been organized and is proceeding under Society auspices.

This new activity will be carried on by a subcommittee, under the regularly organized Committee on Hydraulic Research of the Society's Hydraulics Division. The program for the subcommittee is: (1) to prepare a summary of information on cavitation in hydraulic structures, the extent of damages that have occurred, and an appraisal of remedies that have been proposed; (2) to prosecute research on this subject, including work both in the laboratory and in the field. It is believed that the effect of cavitation on concrete and other structural materials can be largely eliminated by proper design, having regard for the hydraulic conditions that induce this destructive force.

Personnel of the new committee has been chosen as follows:

JOHN K. VENNARD, Jun. Am. Soc. C.E., Assistant Professor of Fluid Mechanics, New York University, chairman.

JOHN C. HARROLD, Assoc. M. Am. Soc. C.E., Engineer, Office of Chief of Engineers, War Department, Washington, D.C.

GEORGE H. HICKOX, M. Am. Soc. C.E., Senior Hydraulic Engineer, Tennessee Valley Authority

IREAL A. WINTER, Assoc. M. Am. Soc. C.E., Senior Engineer, U.S. Bureau of Reclamation

The work of the Committee on Hydraulic Research is under J. C. Stevens, chairman; and that of the Hydraulics Division under Fred C. Scobey, chairman.

Society's Fall Meeting to Be Held in Niagara Falls, Ontario, Canada, October 14 and 15

Photostat and Microfilm Services Popular

PHOTOSTAT and microfilm processes for reproducing documents are attracting increasing attention from day to day, and the experience of the Engineering Societies Library indicates that more and more members are using them. Orders are 25% greater this year than last.

In addition to requests for a single article one or two pages long, orders calling for hundreds of prints come in. Many establishments build up files of all articles relating to their work instead of collecting sets of periodicals. In this way much space is saved, because irrelevant material is eliminated, and what is wanted can be filed according to personal wishes.

Both methods of copying have their advantages. Photostats resemble ordinary documents. They can be filed in the same way, in letter files or loose-leaf binders. Several can be spread out and consulted simultaneously. Other documents can be interfiled with them.

Microfilm copies are cheaper; in fact, when long articles or whole books are to be copied the saving is large. The cost of the film, which is for a 35-mm projector, is $1 for twenty frames (the minimum charge). Each extra frame, in addition to the twenty, costs four cents. To use the microfilm copies some projection apparatus or reading machine is necessary. These machines are not as yet common office equipment, and good ones are rather expensive, costing about what typewriters do. Also, the film is not as easy to store and handle as photostats are.

Perhaps for these reasons most members, up to now, seem to prefer photostat copies. The Library is ready at all times to supply either photostats or microfilms, as desired.

The Hawaii Section and the War

MEMBERS will be interested in news from the Section of the Society that is nearest the theater of war. In a recent letter to Society Headquarters Karl A. Sinclair, president of the Hawaii Section, writes that air mail service to Hawaii is very uncertain these days. Furthermore, "regular mail takes anywhere from two weeks to two months, thirty days being a fair average. . . .

"Outside of a few informal meetings, the Local Section has been dormant since December 7th," Mr. Sinclair reports. "Continuous blackout and curfew laws make it impossible to hold evening meetings. A considerable portion of the membership is in active service in the armed forces, and practically all others are on some sort of defense work and are widely scattered during the day. The hours are long (ten to twelve), and there is no time to think about what happened last month or last year; there is too much to take care of tomorrow.

"Hawaii is really close to the front lines, and there is plenty of evidence of war. However, the general attitude seems to be similar to that of any good construction man—it's just another job; let's finish it and hunt a new one!"

Research Work on Soil Sampling and Testing

DURING the fiscal year now ending, the principal work of the Committee on Sampling and Testing of the Society's Soil Mechanics and Foundation Division, has continued to be the project for Developing Better Methods and Equipment for Obtaining Undisturbed Samples of Earthen Materials. Dr. M. Juul Hvorslev, Assoc. M. Am. Soc. C.E., has been research engineer on the project, which has been generously sponsored by the Engineering Foundation.

During the year he has designed, constructed, and tested samplers for obtaining undisturbed samples of various materials. The design of these samplers embodies the results of his research and experience gained on this project.

Experiments and observations on the operation of the improved samplers were conducted on practical exploration work covering a number of projects in the East. In the laboratory examination, over 800 sample sections were carefully sliced, prepared, and observed, and over 400 of these sections were photographed. In addition, many special tests were made at Harvard University.

The cooperation and assistance of the Graduate School of Engineering and the Soils Laboratory at Harvard University, the laboratories of the Army Engineers, the U. S. Deep Waterways Experiment Station, the Raymond Concrete Pile Company, the Woods Hole Oceanographic Institution, the Carnegie Institution of Washington, and others, have been continued. The cost of these contributions to the project in labor and materials has undoubtedly greatly exceeded the direct cost of the project to the Engineering Foundation.

The Committee desires to take this opportunity to express its gratitude to the Engineering Foundation for the continued support of its work; also for the assiduous research which Dr. Hvorslev has done.

During the fiscal year beginning October 1, 1942, the new project, entitled "Development of Better Methods for Testing Soils," will be undertaken. For this the Committee has been tentatively allotted $5,000 by the Engineering Foundation. The scope is very broad, embracing practically all of soil mechanics. Four principles will govern the selection of specific studies and the prosecution of this project:

1. Soil tests will be studied in relation to the meaning of their results and the ways in which the results can be analyzed.
2. Soil tests will be studied in relation to the ways in which their results can be correlated with, or used in, the analysis of field performance.
3. Tests on undisturbed samples will be studied in relation to the actual behavior of the soil in situ.
4. Soil tests and soil testing methods will be considered only as tools to be used in engineering solutions and not as ends in themselves.

For the duration of the war emergency, the Committee expects its efforts to be devoted exclusively to studies which will yield results of potential value to the armed forces. Professor P. C. Rutledge, Assoc. M. Am. Soc. C.E., is chairman of the Committee on Sampling and Testing.

British Institution Welcomes American Engineers

MEMBERS of the Society whose duties call them to England will be glad to know of the hospitality proffered by the Institution of Civil Engineers of Great Britain, oldest of all national engineering societies. Its secretary, E. Graham Clark, has extended this invitation in a letter dated August 10, to Maj. Gen. John C. H. Lee, M. Am. Soc. C.E., in the following terms:

> "I have been instructed by the Council of the Institution of Civil Engineers to say that they are anxious to extend to all Military Engineers of the United States of America who are now in this country facilities for attending the meetings of the Institution and the use of the Library and Reading Rooms at the headquarters building here.
>
> "The Library and Reading Rooms are open every weekday from 9 a.m. until 5:30 p.m. (Saturdays 12:30 p.m.), but there will not be any meetings until the new session commences in November next."

Engineers who may avail themselves of this kind offer will find much interest in the beautiful building which houses the Institution. It is on Great George Street, in Westminster.

Invitation to India

AMERICAN participation in the war has tended to spread the activities of civil engineers all over the globe. It is quite possible, therefore, that some of our members will find themselves in India, in which event they will be interested in a courteous suggestion forwarded to Headquarters from F. F. Fergusson, Assoc. M. Am. Soc. C.E., whose present address is Jodhpur, Rajputana, India. Mr. Fergusson states:

"I take the opportunity to offer my hospitality to any fellow member of the Society who may, due to his being on war service in

India, be in the vicinity of Jodhpur, or who may be passing through Jodhpur.

"There is a certain amount of interest from the historical point of view to one who does not know India, and a week could be spent here quite pleasantly, possibly by someone undergoing convalescence. The climate, except from April until August, is quite pleasant.

"Any fellow member who would care to do so should send a telegram a few days beforehand so as not to catch me out on a tour of inspection."

This generous invitation is one of several that have recently come to the attention of the Society, indicating the cordiality and spirit of genuine friendliness that exist among members of the civil engineering profession. Many acquaintanceships made in such casual ways have ripened into long friendships. Engineers make good friends.

To Define Ethical Practice—Forum Continues

IN ALL RELATIONS of man to man there are two sides, and sometimes conflicting interests. It is this difference of opinion that makes ethical problems. If the issue were crystal-clear, there could be no discussion, no argument.

Basically, all ethics comes back to the Golden Rule, although such a statement doubtless oversimplifies the case. In practice it is thought that the principle can be illustrated better by means of specific examples than by abstract philosophizing. At least that is the thought behind the attempt now current in CIVIL ENGINEERING to explore the ethics of engineering practice. It is to be done in terms of individual hypothetical circumstances.

That is, a series of questions is to be enunciated one after another and in due course these will be answered by an authority. Meanwhile, opportunity for comment on the questions will be welcomed by members. The first question and its answer were printed in the September number. The second question was also stated, and its answer will be given in the next or November number, thus allowing two months between the statement and the reply to give time for discussion to come in.

Over the course of years many such questions have arisen in the minds of engineers. Each has had to answer them according to his ideals or best judgment. If there is anyone who has devoted more study than customary to such matters, who has brought a high sense of idealism to such considerations, and who, more than all this, has had the courage to follow the leading of a sensitive conscience, that man is Dr. Daniel W. Mead. From the wealth of his experience he will undertake not only to propound the questions but also to answer them.

His answer to Question 2 is promised for the November number. A special place will be reserved for this department under the general heading of "Our Readers Say" where letters of correspondents appear. Meanwhile, comment on the various questions and also suggestions of new topics for consideration are welcomed. The subject now proposed for consideration is as follows:

QUESTION 3: *An engineer supervising the work on a project is able to suggest to the contractor many money-saving methods that do not lower the quality of the work. While on the job the engineer eats at the contractor's mess house. Should he accept his board from the appreciative contractor?*

Any comments on this question may be cleared through the editors. Discussion on Question 3 will remain open until November 5, and will be answered in the following, or December, number.

New Closing Discussions Published in TRANSACTIONS

DURING the next few months, the annual volume of TRANSACTIONS will appear in the mails—paper-bound copies in October, and cloth and leather-bound copies a few weeks thereafter. Many who have followed their special subjects month by month in PROCEEDINGS may be inclined to place this volume in its allotted place on the reference shelf, secure in the feeling that they are aware of its most important contents.

This is an unwise conclusion under present circumstances inasmuch as Vol. 107 will contain 124 pages of new material in the form of authors' rebuttals to arguments raised during discussion. A list of the closing discussions thus published for the first time follows:

METHOD OF PREDICTING THE RUNOFF FROM RAINFALL
By Ray K. Linsley, Jr., and *William C. Ackermann*
EVALUATION OF FLOOD LOSSES AND BENEFITS
By Edgar E. Foster
WIND STRESS ANALYSIS BY THE *K*-PERCENTAGE METHOD
By F. P. Witmer
MISSOURI RIVER SLOPE AND SEDIMENT
By William Whipple, Jr.
RIGID FRAMES WITHOUT DIAGONALS (THE VIERENDEEL TRUSS)
By Louis Baes (closure by Leon G. Rucquoi)
CONSUMPTIVE USE OF WATER FOR AGRICULTURE
By Robert L. Lowry, Jr., and *Arthur F. Johnson*
AN INVESTIGATION OF PLATE GIRDER WEB SPLICES
By J. M. Garrelts and *I. E. Madsen*
COMPACTION OF COHESIONLESS FOUNDATION SOILS BY EXPLOSIVES
By A. K. B. Lyman
COST OF PUBLIC SERVICES IN RESIDENTIAL AREAS
By F. Dodd McHugh
SALTS IN IRRIGATION WATER
By Raymond A. Hill
A DIRECT METHOD OF FLOOD ROUTING
By C. O. Wisler and *E. F. Brater*
PIPE-LINE FLOW OF SOLIDS IN SUSPENSION: A SYMPOSIUM
DESIGN AND CONSTRUCTION OF SAN GABRIEL DAM NO. 1
By Paul Baumann

All the papers reflect in some measure the needs of a nation fighting a desperate war, and some of them were affected by the war in a very real sense. For example, after Louis Baes, professor at the University of Brussels in Belgium, submitted his paper, war began and Belgium was invaded; the normal difficulties of communicating with overseas authors were increased infinitely. The paper was published in PROCEEDINGS in January 1941. It was due largely to the interest of L. G. Rucquoi, M. Am. Soc. C.E., a personal friend of Professor Baes, that the paper could be published at all. The Society has been unable to reach Professor Baes for many months, as stated by Mr. Rucquoi in a few closing comments on the paper.

SALVAGE OF SLUDGE

A joint effort of the Sanitary Engineering Division and the Irrigation Division, the Final Report on Salvage of Sewage forms an important part of Vol. 107 of TRANSACTIONS that has not been published before. This joint Division effort was organized during the latter part of 1933, and two progress reports have been published in previous issues of CIVIL ENGINEERING (September 1934 and April 1935).

The final report is a notable and comprehensive one. It deals with public health considerations, the reclamation and general reuse of water from sewage, use of such water in industry, reclamation and use of sewage fertilizer, and the reclamation of grease. Not the least important part of the report is a bibliography of 65 references.

AMERICAN SOCIETY OF CIVIL ENGINEERS TODAY

Advancement in the art of civil engineering for 90 years may be said to have been defined by the successive volumes of TRANSACTIONS, 107 in number. The publication of these volumes is one of the Society's most important responsibilities. The President's annual address characteristically summarizes professional progress, and the addresses of past years always make interesting reading in the light of the present.

The address delivered by President E. B. Black at the Minneapolis Meeting in July 1942 is noteworthy as one of the most detailed definitions of the Society's aims and accomplishments ever published. The work done and future work planned by the Society in the war effort have occupied the attention of the President constantly during his busy term of office.

This year it was not possible, as in former years, to issue preprints of the address at the meeting, and later to report it in CIVIL ENGINEERING. The TRANSACTIONS printing will be its first appearance, and it is hoped that members will find it profitable reading.

Appointments of Society Representatives

E. B. BLACK, President, Am. Soc. C.E., has been appointed one of the Society's representatives on the John Fritz Medal Board of Award for the four-year term, October 1942–October 1946.

C. B. BURDICK, M. Am. Soc. C.E., acted as the Society's delegate at the dedication exercises of the Northwestern Technological Institute at Evanston, Ill., on June 15, 1942.

J. W. ORTON, Assoc. M. Am. Soc. C.E., represented the Society at the annual meeting of the American Institute of Architects, which was held in Detroit, Mich., June 23–25, 1942.

F. E. RICHART, M. Am. Soc. C.E., has been appointed a Society representative on the Sectional Committee on Specifications for Portland Cement.

F. A. RUSSELL, M. Am. Soc. C.E., was the Society's representative at the annual meeting of the Society for the Promotion of Engineering Education, held in New York City, June 27–29, 1942.

ARTHUR S. TUTTLE, Past-President and Honorary Member, Am. Soc. C.E., was appointed to represent the Society at the inauguration of Dr. Harry Noble Wright as president of the College of the City of New York on September 30.

News of Local Sections

Scheduled Meetings

CENTRAL OHIO SECTION—Luncheon meeting at the Fort Hayes Hotel on October 15, at 12 m.

CINCINNATI SECTION—Dinner meeting at the Student Union, University of Cincinnati, on October 20, at 6:45 p.m. (R. T. Howe will speak on "Wright Builds for Air Supremacy.")

COLORADO SECTION—Dinner meeting at the University Club on October 12, at 6:30 p.m.

DAYTON SECTION—Luncheon meeting at the Engineers' Club on October 19, at 12:15 p.m.

ITHACA SECTION—Annual meeting at Willard Straight Hall on October 22, at 6:30 p.m.

LOS ANGELES SECTION—Dinner meeting at the University Club on October 14, at 6:15 p.m.

METROPOLITAN SECTION—Technical meeting in the Engineering Societies Building on October 21, at 8 p.m.

MIAMI SECTION—Dinner meeting at the Seven Seas Restaurant on October 1, at 7 p.m.

NASHVILLE SECTION—Dinner meeting at Vanderbilt University on October 6, at 6 p.m.

NORTHWESTERN SECTION—Dinner meeting at the Minnesota Union on October 5, at 6:30 p.m.

PHILADELPHIA SECTION—Dinner meeting at the Engineers' Club on October 13, at 6 p.m.

ST. LOUIS SECTION—Luncheon meeting at the York Hotel on October 27, at 12:15 p.m.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday at 12:15 p.m.

SAN FRANCISCO SECTION—Dinner meeting at the Engineers' Club on October 20, at 5:30 p.m.

SEATTLE SECTION—Dinner meeting at the Engineers' Club on October 26, at 6:30 p.m.

TEXAS SECTION—Luncheon meeting of the Dallas Branch at the Dallas Athletic Club on October 5, at 12:10 p.m.

Recent Activities

INDIANA SECTION

Various business matters were discussed at the August 21 meeting of the Indiana Section, and two vacancies on the roster of Section officers were filled. Don E. Bloodgood will replace Denzil Doggett, as secretary-treasurer, Mr. Doggett having been called to active military service; while Ralph E. Simpson will fill the office of vice-president, which was left vacant by the death of M. R. Keefe. The speaker was R. B. Wiley, Director of the Society, who gave a résumé of the Board of Direction meeting at Minneapolis and discussed some of the problems facing the Society.

SACRAMENTO SECTION

Throughout the summer months the Sacramento Section continued its custom of holding weekly luncheon meetings. Among those addressing the July and August gatherings were T. E. Stanton, materials and research engineer for the California State Division of Highways, who spoke of the present necessity for streamlining the manufacture of cement and the resultant standardization of five types in various combinations of lime, silica, alumina, and iron; C. J. Miller, senior entomologist for the U.S. Bureau of Entomology and Plant Quarantine, who discussed insect damage to the forests; Franklin P. Ulrich, chief of the Seismological Field Survey of the U.S. Coast and Geodetic Survey, whose subject was "Distribution of Destructive Earthquakes"; and Prof. B. A. Madsen, of the University of California college of agriculture, who spoke on the possibility of making synthetic rubber from the guayule plant. On one occasion R. M. Beanfield, consulting engineer, showed several colored films of Hawaii and described his experiences there during the raid of December 7. Another session was devoted to a symposium on "Salvage of Vital War Materials," the speakers being George R. Winkler and Charles A. Wall.

SAN FRANCISCO SECTION

A regular bi-monthly meeting of the San Francisco Section took place on August 18. Following dinner, Vice-President Samuel B. Morris reported on the Local Sections Conference, held at the time of the Minneapolis meeting. The technical program consisted of an address by Walter C. Smith, Pacific district engineer for the General Electric Company, whose subject was "Trends in Electrical Development and Research." Mr. Smith enumerated recent developments in the design of instruments, meters, and other electrical equipment and outlined the vast amount of research work that has been done, particularly in the field of radio detection. He showed pictures of compact mobile power plants and complete transformer units, which are marketed ready for installation, and described the massive generator and circuit control units designed for the Boulder Dam and Grand Coulee power plants. His talk was illustrated with lantern slides.

On July 23 there was a meeting of the Junior Forum, at which two members of the Forum spoke. Joseph Pirtz, Jr., field and office engineer for the Pacific Gas and Electric Company, discussed "Priority Difficulties in Defense Construction," and Jack Hughes, of the Permanente Metals Corporation, spoke on the subject of "New Methods of Shipbuilding." The topic for general discussion was "The Citizens' Responsibility in a Wartime Democracy."

TENNESSEE VALLEY SECTION

On August 8 and 9 members of the Knoxville Sub-Section enjoyed an interesting inspection trip. Meals and shelter for the group had been provided at Farner, Tenn., from which the group went by bus to the Apalachia, Turtle Creek, and MacFarland adits of the tunnel, which is being constructed from the dam to the power house. Opportunity was afforded to enter two sections of the tunnel. Drilling operations were in progress in one of these sections, and in the other concreting of the arch of the tunnel lining was being done. In the evening there was a meeting of the Sub-Section, at which Charles W. Okey, president of the Tennessee Valley Section, reported on the Minneapolis meeting. He was followed by George K. Leonard, project manager for the Apalachia Project, who discussed the administration and management of large engineering projects. On Sunday morning the group was taken to the power house end of the tunnel, where the operations of excavating and lining the surge tank were viewed.

ITEMS OF INTEREST

About Engineers and Engineering

Civil Engineering for November

Skyrocketing demands for steel to fill war orders have shaken many structural engineers out of their routine of designing by means of steel handbooks. Timber has filled the breach admirably, and from all indications it will continue to hold its place as an important structural element. In his article to appear in the November issue, Prof. H. J. Hansen, of the Agricultural and Mechanical College of Texas, sponsors this material, decries the lack of trained timber designers, and points to the necessity of including timber design in the curricula of engineering colleges.

Silt control could have saved many ancient communities, and can today conserve rich farm lands and preserve reservoir capacities. After years spent in the study of this subject, W. E. Corfitzen of the Bureau of Reclamation presents his analysis of the problem which is costing the nation millions of dollars a year.

In many places along our coasts marine borers have caused considerable damage, and the peculiar habits of the various organisms concerned may often puzzle engineers. For instance, some are stopped by creosote treatment of piling while others unfortunately are not. Often a casual inspection of a structure will not disclose the extent of the damage, and serious trouble may result. On the Gulf coast of Florida, certain protective measures have been used with success, as reported by Winston E. Wheat, County Engineer of Escambia County, Fla., in the November number.

A comparison of formulas for the computation of superelevation of open channels at bends has been made by J. G. Jobes and J. H. Douma, of the U.S. Engineer Office at Los Angeles. The determination of wall heights at channel bends is directly dependent upon such research. The laboratory facilities of the California Institute of Technology were used in these experiment.

Standard for Instruction of Welding Operators

A new tentative standard, entitled "Code of Minimum Requirements for Instruction of Welding Operators, Part A—Arch Welding of Steel $^3/_{16}$ to $^3/_4$ In. Thick," has been approved and published by the American Welding Society. This Code represents a revision. In the process the Code was considerably expanded, particularly with respect to the supplementary material given in the appendixes as suggestions to persons organizing courses in metal arc welding. The main body of the Code includes sections on equipment and facilities of the school, qualifications and duties of the instructor, instruction in welding practice, instruction in welding theory, and final tests. There are nine appendixes of suggested and recommended material, and a selected bibliography.

The Code was published in the form of a 68-page booklet with a heavy paper cover, and is available at 50 cents a copy from the American Welding Society, 33 West 39th Street, New York, N.Y.

N. G. Neare's Column

Conducted by

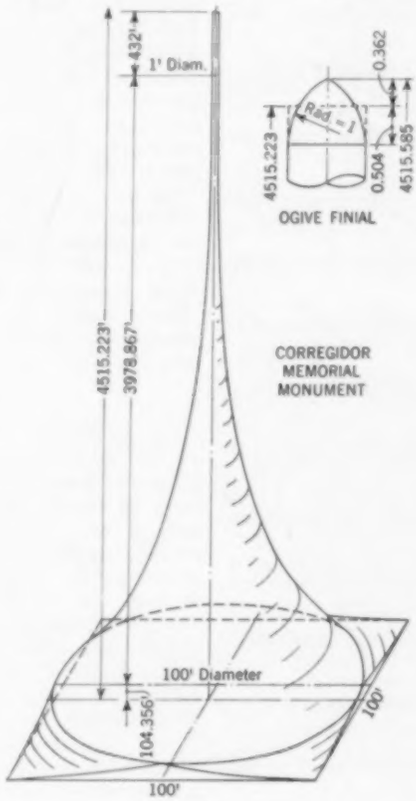
R. Robinson Rowe, M. Am. Soc. C.E.

"Before Professor Scrubal starts his elegant symposium on *Live Moments in Penthouses*, we have a special order of business—to fix the height of the Corregidor Memorial Monument. Its concrete shaft on a 100-ft square base must not bear more than 450 lb per sq in. (average) on any horizontal section nor be anywhere thinner than one foot. Who can build to the limit?"

"Professor Neare, that's the easy problem, I've been waiting for for 4 months," piped Joe Kerr. "If A is the area of shaft section at elevation z, then we can equate increments of weight and bearing capacity:

$$\begin{aligned} 150A(-dz) &= 450 \cdot 144\, dA \\ dz &= -432\, dA/A \\ z &= -432\, 10gA + \text{constant} \\ &= 432\, 10g(10{,}000/A) \end{aligned}$$

"This is a logarithmid, reaching the zenith at $A = 0$, $Z = \infty$. It must be truncated at $A = 1$, $z = \log 10^{173} = 3{,}978.867$ ft."



"I can build it higher," added Cal Klater. "Replace the part that Joe cut off with a square mast of equal weight and 432 ft long; then the shaft will be 4,410.867 ft high. But I warn you, the wind stress will be appalling. Better build it at Kiska where the fog will give lateral support."

"Good!" exclaimed the Professor. "But another 100 ft would be closer."

"I had Cal's answer in mind," said Ken Phygger, "but I see what you mean now. Since a 1-ft cylinder is no thinner than 1 ft, Joe's A may be $\pi/4$. Making Cal's mast the same height but cylindrical, the total height is 432 log $(40{,}000e/\pi) = 4{,}515.223$."

"That's the tentative design, Ken. To minimize wind pressure, the transition from square to round is made in a base block, as shown in the sketch. Above the block is a logarithmoid of revolution, then the mast."

"Just a minute, Noah," interrupted Matt Mattix. "How do you define 'thinness'?"

"As scantness of depth normal to surface."

"Then I'd dome the mast with a hemisphere, replacing an equal weight of cylinder—making the height 4,515.390 ft."

"Excellent, Matt. But wouldn't a Gothic dome be higher?"

"Yes, and that must be the limit, too. Easy to figure if you wait a minute..... 4,515.585 ft. I'd call it a single-caliber ogive finial."

"And I call it the last word. Now let's get back to arithmetic, literally—where letters are substituted for digits:

1. Addition

   BONDS
   SCRAP

   ARMOR

2. Multiplication

   TENLIS
   UP

   ENLIST
   LISTEN

   LOOOOOT

3. Division (to be completed)

   CIVIL (ENGINEER) CO
   VRAEE

   AANCLE

4. Proportion YR:US = DHI:LCA
5. Involution MAN^V = BRAVE-MAN

"In the first, make all the armor you can; in the last, see what V-power does to an ordinary chap."

[The able Cal Klaters were Richard Jenney, G. H. Wilsey, Frederick V. Pohle, David E. Hughes, George T. Dean, Dean F. Peterson, Jr., H. E. Kuphal, and Joseph S. Lambie. Correct second-guessing Ken Phyggers were Jenney and Hughes. The latter, as Matt Mattix, went on to study s designs for the finial.]

Activities of the Army Engineers

In Preparation

In Use

Photos Used Through Courtesy of U.S. Army Engineer Corps and U.S. Army Signal Corps

Take an Inventory Now

Industry Advised to Obtain Replacements as Military Manpower Needs Increase

By MAJ. GEN. LEWIS B. HERSHEY
DIRECTOR OF SELECTIVE SERVICE

MANPOWER is a most important strategic material of today. Every employer should make a prompt inventory, appraisal, and analysis of the manpower in his own plant as he would inventory his stock pile. In order to keep production going and, at the same time, furnish men for the armed forces, industry should now establish an orderly replacement program.

In order to secure temporary deferments for essential men while he is training women, young men, older men, men physically handicapped, or those with a high degree of dependency, the employer should know the fundamental principles in the operation of his local Selective Service Board. Certain steps should now be taken by each employer. The employer should know how many men on his payroll are between the ages of 20 and 45. He should investigate the classification of every one of those men. On the basis of such an inventory he should prepare to plan ahead and train men for the replacement of those who must necessarily enter the armed forces if we are to have the sort of army that can win the war.

Deferments, granted so that employers may train women or men not liable to early induction, are temporary deferments; they cannot exceed six months and in many cases may be for only thirty, sixty, or ninety days. Today the Army has to train a bomber pilot within a period of eight months to operate a very technical machine with an instrument board which puzzles an expert. Why, then, should industry assume that it can take two or three years to train men for industrial tasks that are not nearly so complicated?

The fundamental purpose of every deferment of a registrant is to allow an employer to train a replacement. Only in a few rare instances can an employer expect to have these temporary deferments continued for more than the six months' period. A good rule to follow: Don't ask deferments for any men who can be replaced by training another individual not likely to be eligible soon for service in the armed forces. Make an inventory, request deferment for any man whose immediate going into the armed services would retard production of vital war material or other services essential to the war effort, or who is needed to maintain national health, safety, and interests.

There are not more than sixty million people in this country who are capable of effective productive effort. These men and women represent our total manpower available to win the war. They must do everything that must be done in a total war: Maintain transportation, communications, and utility systems; maintain public services; grow food for ourselves and our allies; mine the metals and produce the raw materials; fabricate and produce the amount of consumer goods necessary to maintain even a restricted national life and the supplies, weapons, and munitions of war. Most of all, they must provide the men who land on strange shores in far places, the men who carry the fight to the enemy on a multitude of far-flung frontiers. The rest of the population who mine raw materials and produce the weapons with which these men fight must be a self-disciplined team working in unity. The individual personal convenience, comfort or pleasure, or the convenience and ordinary leisurely replacement programs of the employer, will have to be given progressively less consideration as the war gets tougher and the casualty lists grow.

Brief Notes

"SAVE manpower for warpower" is the slogan of the Thirty-first National Safety Congress and Exposition to be held by the National Safety Council in Chicago, October 27–29. This, the first wartime Safety Congress since 1918, will be devoted completely to the safety job now at hand—to help win the war. Its 175 sessions and 500 participants will cover every phase of the problem today. Details may be secured from the National Safety Council, 20 North Wacker Drive, Chicago.

* * * *

IT IS announced that the Engineers' Council for Professional Development will hold its Tenth Annual Meeting on October 18, at 9:30 a.m. in the Board Room of the American Society of Civil Engineers, 33 West 39th Street, New York, N.Y. The meeting of the Council's executive committee will be held on the preceding day, October 17, at the same hour and place.

NEWS OF ENGINEERS

Personal Items About Society Members

RALPH A. TUDOR, lieutenant colonel, Corps of Engineers, U.S. Army, is now in Portland, Ore., where he is in charge of the Engineering Section of the Portland District Office of the U.S. Engineer Office.

B. T. HUDSPETH, who entered the service as captain of Infantry in January 1941 and was recently promoted to major, is now stationed at the Presidio of San Francisco, where he has been assigned to the Fourth Ground Air Service Command.

CHARLES F. WEDDINGTON, until recently assistant district engineer for the Texas State Highway Department at Pecos, Tex., has accepted a commission as captain in the Corps of Engineers, U.S. Army, with headquarters at Fort Sam Houston.

WILLIAM D. WALTMAN, president of the Franco Wyoming Oil Company, Los Angeles, Calif., was the recipient of an honorary engineering medal from his alma mater, the Colorado School of Mines, during the past commencement season.

A. J. M. GIARDINI, formerly project manager for the Wadhams, May and Carey Company at the U.S. Submarine Base at New London, Conn., is now president of the Associated Construction Company, with headquarters at Groton, Conn.

CHARLES M. NOBLE has received an appointment as lieutenant commander, CEC, U.S. Naval Reserve. For the past year Commander Noble has been with the U.S. War Department at Arlington, Va.

G. GALE DIXON, until recently chief sanitary engineer for Caribbean Architect-Engineer in the design of water supply and sewerage facilities for the Army bases in the southern Caribbean area, is now associated with Parsons, Klapp, Brinckerhoff and Douglas, New York City engineers.

GEORGE ALLEN RIDGEWAY, general inspector of construction for the Missouri State Highway Department, has been commissioned a major in the Missouri River Division of the Corps of Engineers, U.S. Army.

W. F. TRIMBLE, JR., is now president of the Trimble Company, a new Pennsylvania Corporation organized to succeed the W. F. Trimble and Sons Company and carry forward its business in the general construction field. The company has its offices in Pittsburgh.

HOMER W. JORGENSEN, previously assistant sanitary engineer for the California State Bureau of Sanitary Engineering at Berkeley, Calif., is with the U.S. Engineer Department at Los Angeles.

JOHN M. SERVER, JR., has accepted a position as assistant editor for *Western Construction News*, with headquarters in San Francisco. He was formerly a civil engineer for the Los Angeles County Flood Control District.

JOHN F. LONG, until recently in the Houston (Tex.) office of the U.S. Engineers, has been transferred to the Louisville (Ky.) district office of the same organization, where he is employed in the specifications section for housing, hospitals, cantonments, depots, and utilities.

RAYMOND R. ZACK has been named acting engineer of estimates and contracts for the Iowa State Highway Commission. He was previously district engineer at Mason City.

LEON MASLAN, formerly assistant civil engineer in the U.S. Engineer Office at Savannah, Ga., has been called to active service as a second lieutenant with the 360th Engineer Regiment at Camp Claiborne, La.

PERLEY M. LEWIS, captain, Corps of Engineers, U.S. Army, was recently appointed area engineer for the Army Air Force Technical School at the Lincoln (Nebr.) Air Base.

EDMUND FRIEDMAN has been granted a leave of absence from his duties as county engineer of Dade County, Florida, in

order to accept a captain's commission in the Corps of Engineers.

THOMAS H. MILFORD will become chief engineer of the sanitary bureau of the Alabama State Health Department. Until lately he was associate engineer for the J. W. Goodwin Engineering Company in Birmingham, Ala.

E. L. WITTENBORN, JR., is now sanitary engineer for the Midland Ordnance Corporation near Illiopolis, Ill. He was formerly employed in a similar capacity by the Illinois State Department of Public Health.

JOHN C. BISSET recently resigned as assistant director of public works at Dallas, Tex., in order to accept a commission as major in the Corps of Engineers, U.S. Army. At present he is stationed at Chickasha, Okla.

WILLIAM H. HARVIE, road engineer for the Michigan State Highway Department, Lansing, Mich., has been commissioned a major in the Corps of Engineers.

J. L. SORBEL is with the sanitary engineering division of the South Dakota State Board of Health, his present headquarters being Hot Springs, S.Dak.

HARRY HENDON, who recently resigned as chief engineer of Jefferson County, Alabama, has accepted a connection with Converse and Polk, Birmingham consultants. Mr. Hendon will be in charge of the design of roads and water and sewerage facilities.

B. A. POOLE has taken a leave of absence from his position as chief sanitary engineer for the Indiana State Board of Health in order to join the Sanitary Corps of the U.S. Army. He will have the rank of captain.

SOPHUS THOMPSON, professor of civil engineering at Southern Methodist University, has entered army engineer training work at Fort Belvoir, Va.

J. E. BUCHANAN has reported for active service as a reserve first lieutenant at the Engineering Replacement Training Center at Camp Leonard Wood, Mo. Until lately he was dean of the college of engineering at the University of Idaho.

HARRY D. LOVERING, major, Corps of Engineers, U.S. Army, has been transferred from the U.S. Engineer Office at Grand Island, Nebr., to the district office at Denver, Colo.

H. M. MARTIN, first lieutenant, Corps of Engineers, U.S. Army, was recently appointed area engineer on the construction of an addition to the Fitzsimmons General Hospital, near Denver, Colo.

STANLEY T. BARKER has been promoted to the rank of commander, CEC, U.S. Naval Reserve. Commander Barker is still in the Aviation Facilities Division of the Bureau of Yards and Docks, Washington, D.C., and is now executive assistant to the head of the Division as well as Bureau project manager on the construction of a number of naval air stations.

LAWRENCE B. FEAGIN, lieutenant colonel, Corps of Engineers, U.S. Army, is now district engineer for the St. Louis Missouri Engineer District. Colonel Feagin was formerly head engineer for the District, serving in a civilian capacity.

LESTER L. LESSIG has been granted an indefinite leave of absence from his position as contracting engineer for the Bethlehem Steel Company in order to report for active duty as major in the Corps of Engineers, U.S. Army. At present Major Lessig is assigned as chief of the control section of the U.S. Engineer Office in Philadelphia.

AUGUSTUS GRIFFIN, for the past year assistant manager of the Department of Natural Resources of the Canadian Pacific Railway, with headquarters at Calgary, Alberta, has been made manager. He will succeed S. G. PORTER, retiring manager, who has headed the branch since 1927.

UEL STEPHENS is leaving the regional office of the Federal Works Agency in Fort Worth, Tex., to become connected with the regional office of the Federal Public Housing Authority, his headquarters remaining in Forth Worth. In his new position he will serve as regional construction adviser and will have charge of the Federal public housing construction program in Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

A. J. MALLOY, captain, Corps of Engineers, U.S. Army, has been transferred from Houston, Tex., where he was assistant area engineer at the San Jacinto Ordnance Depot, to Austin, Tex., where he is area engineer at the Del Valle Airfield.

E. E. SCHOLER, formerly highway engineer for the Shell Oil Company at St. Louis, Mo., is now general superintendent for the Dickie Construction Company on the construction of a naval air-base project.

KENNETH C. TIPPY, since 1936 engineer for the Portland Cement Association, Chicago, Ill., has been appointed assistant professor of civil engineering at Syracuse University, where he will have charge of the hydraulics and materials testing laboratories in the college of applied science.

DECEASED

CHARLES HENRY GAEDCKE (Assoc. M. '22) refinery piping designer for E. B. Badger and Sons Company, of Boston, Mass., died in Elizabeth, N.J., on August 16, 1942. Mr. Gaedcke, who was 49, was with the Tide Water Oil Company, of Bayonne, N.J., for a number of years. Recently he had joined the staff of E. B. Badger and Sons Company.

LEON RAYMOND GURLEY (M. '41) senior engineer for Coverdale and Colpitts, of New York City, died on August 26, 1942, at the age of 49. From 1917 to 1919 Mr. Gurley served with the A.E.F. in France, having the rank of first lieutenant; from 1919 to 1921 was a partner in Gurley and Gurley, of Houston, Tex.; and from 1921 to 1929, senior engineer for James L. Darnell, New York City engineer. Later he was consulting engineer for Carl H. Pforzheimer and Company, of New York, and from 1936 on was with Coverdale and Colpitts.

GUSTAVE BERNARD HEGARDT (M. '08) retired consulting engineer of Oakland, Calif., died on September 1, 1942. Mr. Hegardt, who was 83, was for some years port manager and chief engineer of the Port of Oakland. He had also been consultant to the Port. Earlier in his career he was engineer and secretary for the Portland (Ore.) Commission of Public Docks.

CLARK ELLSWORTH JACOBY (M. '21) drainage engineer and assistant to the chief of the U.S. Soil Conservation Service at Milwaukee, Wis., died at his home in that city on August 24, 1942. He was 62. For a number of years Mr. Jacoby maintained a consulting practice in Kansas City, Mo. Later (1936) he became drainage engineer for the Bureau of Agricultural Engineering of the U.S. Department of Agriculture at Kansas City, and in 1940 was transferred to Milwaukee to serve in a similar capacity with the Soil Conservation Service.

FREDERICK HENRY KESTER (M. '41) consultant for the Canadian Bridge Company, Ltd., of Walkerville, Canada, died at his home in Detroit, Mich., on August 6, 1942. Mr. Kester, who was 56, had been with the Canadian Bridge Company since 1907, having been successively draftsman, assistant engineer, vice-president, and general manager. During this long period he was engaged on the construction of a number of Canada's important bridges.

ALBERT K. B. LYMAN (M. '38) colonel, Corps of Engineers, U.S. Army, Schofield Barracks, Hawaii, died in Honolulu on August 13, 1942, at the age of 57. A native of Hawaii, Colonel Lyman was educated at West Point and spent his entire career in the Corps of Engineers. He had been district engineer at Cincinnati, Duluth, and Boston; chief of the Finance Division, Office of the Chief of Engineers, Washington, D.C.; and commanding officer of the 14th Engineers in the Philippines. During the first World War he served in this country and France, attaining the rank of colonel. In 1940 Colonel Lyman was transferred to Hawaii.

JOHN WALTER MAY (M. '31) construction manager for United Engineers and Constructors, Inc., Philadelphia, Pa., died in that city on August 9, 1942, at the age of 57. From 1900 to 1913 Mr. May was with the Albertson and Young Company, of Atlantic City, N.J.; from 1913 to 1918 manager of construction for George B. Clopp, of Philadelphia; and from 1918 to 1928 general superintendent of Day and Zimmermann, Inc., of Philadelphia. Since 1938 he had been with United Engineers and Constructors in charge of numerous large projects in the Philadelphia area.

GEORGE PAASWELL (M. '20) died recently in Iran, where he went in the fall of 1941 in the capacity of chief engineer of the Iranian Mission for the Army—a

combine of Foley Brothers and Spencer, White and Prentis. He was 55. From 1909 to 1925 Mr. Paaswell was designer and section engineer on subway construction for the New York City Public Service Commission and the Board of Transportation, and from 1925 to 1935 was chief engineer for the Corson Construction Corporation and J. Meltzer, Inc. For the last two years of this period he was in charge of the construction of two Mississippi River locks. From 1935 on he was connected with Spencer, White and Prentis—for part of the time as secretary and treasurer of Spencer and Ross, Detroit subsidiary of the organization.

LEWIS WALTER RUSSELL (M. '34) president, Homes and Farrell, Inc., Oneida, N.Y., was killed in a construction accident at North Evans, N.Y., on July 3, 1942. He was 49. From 1922 to 1936 Mr. Russell was superintendent for the Bates and Rogers Construction Company, of Chicago, Ill., engaged on various bridge and grade-crossing elimination projects. Since 1936 he had been president of Homes and Farrell, Inc. During the first World War he served with the 13th Engineers (Railway) in the A.E.F.

ARTHUR MONROE SHAW (M. '11) of New Orleans, La., died in Paramaribo, Dutch Guiana, on August 2, 1942, as the result of a fall, which he sustained while in charge of a large construction project for the W. Horace Williams Company, of New Orleans. Colonel Shaw, who was 71, had a consulting practice in New Orleans for many years, specializing in drainage and reclamation projects and railroad work. He spent several years in China on the construction of standard-gage railroads for that country. During the first World War he served as a major of engineers in charge of camp construction.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

CHARLES KUNO TRABER (M. '26) chief engineer for A. Leschen and Sons Rope Company, of St. Louis, Mo., died on July 24, 1942. Mr. Traber, who was 65, had been with A. Leschen and Sons Company for a number of years—for the past ten years as chief engineer.

NICHOLAS DOREMUS WORTENDYKE (Assoc. M. '99) of East Orange, N.J., died at his home in that city on August 6, 1942, at the age of 87. In 1882 Mr. Wortendyke opened his own engineering office in Jersey City. Later he became assistant engineer of the Board of Street and Water Commissioners of Jersey City. He was promoted in 1900 to assistant chief engineer of the Board, retaining the same position in the present Department of Public Works, which absorbed the Board in 1913. He retired in 1932.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From August 10 to September 9, 1942, Inclusive

ADDITIONS TO MEMBERSHIP

ADAMS, WALLACE THEODORE (Assoc. M. '42), Sales Engr., W. Q. O'Neall Co. of Illinois, 631 Princeton St., Springfield (Res., 316 West Clark Ave., Effingham), Ill.

ANDERSON, ALLEN JAMES (Assoc. M. '42), Lt., (jg), CEC-V (S), U.S.N.R., War Plans Div., Bureau of Yards and Docks, 4404 Navy Bldg., Washington, D.C.

BARON, FRANCIS MARTIN (Assoc. M. '42), Asst. Prof., Civ. Eng., Dept. of Civ. Eng., Yale Univ., 15 Prospect St., New Haven, Conn.

BLICKLE, RAYMOND RENKEN (Assoc. M. '42), Engr. Designer, Giffels & Vallet, Inc., Nebraska Ordnance Plant, Wahoo (Res., 1005 East 2d St., Fremont), Nebr.

BONNER, WILLIAM MITCHEL, JR. (Assoc. M. '42), Structural Engr., Senter, Wood & Craig, Philtower Bldg. (Res., 920 West 18th St.), Tulsa, Okla.

BROADFOOT, HOLLIS LEE (M. '42), Constr. Engr., TVA, Gilbertsville, Ky.

CAREY, JOHN FOSTER (Assoc. M. '42), Box 255, Cornelia, Ga.

CARSON, ARTHUR BRINTON (Assoc. M. '42), Res. Engr., Henry W. Horst Co., 1505 Race St. (Res., 1415 Survey Lane), Philadelphia, Pa.

CHIN-PARK, EDWARD (Jun. '42), Junior Engr. (Architectural), U.S. Engr. Office, Wright Field (Res., Y.M.C.A., Room 1012), Dayton, Ohio.

CLARK, CHARLES WASHINGTON (Assoc. M. '42), Eng. Designer, Leeds, Hill, Barnard & Jewett, Edison Bldg., Los Angeles (Res., 2123 Veteran Ave., West Los Angeles), Calif.

CLINKSCALES, AUSTIN BROWNLEE, JR. (Assoc. M. '42), 1812 Washington Ave., Greenville, Miss.

COLE, CHARLES WHITMORE, JR. (Jun. '42), (Chas. W. Cole & Son), 220 West La Salle St., South Bend, Ind.

CONTELLO, ANTHONY JOSEPH (Assoc. M. '42), Asst. Civ. Engr., Federal Works Agency, 70 Columbus Ave., New York (Res., 287 Clinton Ave., Brooklyn), N.Y.

COOK, JOHN HENRY (Assoc. M. '42), County Engr., County of Tarrant, Court House, Fort Worth, Tex.

CRENSHAW, JOHN WERNER (M. '42), Associate San. Engr., War Dept., Camp Davis (Res., 1001 Mercer Ave., Wilmington), N.C.

CUMMINS, JOHN ROBERT (Assoc. M. '42), Vice-Pres., Cummins Constr. Corp., 803 Cathedral St., Baltimore, Md.

ELIOT, MILTON EARL (Assoc. M. '42), Chf. Engr., Dallas Plant, Mosher Steel Co., 5101 Maple Ave. (Res., 4315 Fairfax Ave.), Dallas, Tex.

ENGLISH, CYRIL SCALES (Assoc. M. '42), Chf. of Party, U.S. Bureau of Reclamation, Redding, Calif.

ENSZ, HERBERT (M. '42), Head, Testing and Inspection Section, Dept. of Subways and Superhighways, 20 North Wacker Drive, Chicago, Ill.

FARRELL, ROBERT EDWARD (Jun. '42), 2d Lt., Corps of Engrs., U.S. Army, Army Post Office 989, Care, Postmaster, Seattle, Wash.

FARWELL, JOSEPH WILLARD (Assoc. M. '42), Engr., Am. Mutual Liability Ins. Co., 142 Berkeley St., Boston, Mass.

FELD, LESTER SOLOMON (Jun. '42), Junior Civ. Engr., Maps and Surveys Div., TVA, Pound Bldg., Chattanooga, Tenn.

FELDT, HAROLD WALTER (Assoc. M. '42), Associate Engr., U.S. Engr. Office, Wright Bldg. (Res., 514 West 13th St.), Tulsa, Okla.

FOX, PORTLAND PORTER (Assoc. M. '42), Geologist, TVA, Administration Bldg., Gilbertsville, Ky.

FOY, HAROLD CLARKSON (Assoc. M. '42), Engr., Corps of Engrs., U.S. Army, Camp Bowie (Res., 1807 Sixth St.), Brownwood, Tex.

FRIEDMAN, SAM (Jun. '42), Associate Engr. (Structural), U.S. Army Engrs., 751 South Figueroa St. (Res., 3781 Virginia Rd.), Los Angeles, Calif.

GADBERRY, JAMES WILLIS (Assoc. M. '42), Civ. Engr., Bechtel-McCone-Parsons Corp., Louisiana, Mo.

GAMER, ROBERT LICK (Jun. '42), Asst. Geologist, U.S. Bureau of Reclamation, Old Post Office Bldg. (Res., 1424 N St.), Sacramento, Calif.

GAUNTT, JAMES GILLIS (M. '42), Gen. Mgr., Mark K. Wilson Co., 406 Loveman Bldg. (Res., 3115 Rose Terrace), Chattanooga, Tenn.

GILLESPIE, JOHN SANBORN (M. '42), Dist. Engr., State Road Comm., 2224 Fifth Ave. (Res., 165 Woodland Drive), Huntington, W.Va.

GREENE, RONALD (M. '42), Archt., Arcade Bldg., Asheville, N.C. (Res., 1216 Watauga St., Kingsport, Tenn.)

HENRY, HUGH BENJAMIN (Assoc. M. '42), Associate Highway Engr., TVA (Res., 635 Godfrey St.), Knoxville, Tenn.

HILDEBRANDT, CHRISTIAN FRANK (Assoc. M. '42), Chf., Architectural and Eng. Section, Dist. Engrs., Office, Farm Security Administration, U.S. Dept. of Agriculture, 17 Brief Ave. (Res., 209 Copley Rd.), Upper Darby, Pa.

HOOKER, JOHN TANNER (Jun. '42), Ensign, CEC, U.S.N.R., U.S. Naval Constr. Training Center, Davisville, R.I.

HOWARD, HARRY, JR. (Jun. '42), 1207 California Rd., Eastchester, N.Y.

JOHNSON, JOSEPH LEMUAL (Assoc. M. '42), Structural Designer, Chas. T. Main, Inc., Holston Ordnance Works, Kingsport (Res., 1119 Welbourne Ave., Johnson City), Tenn.

KAUFMAN, ARTHUR WILLIAM (Jun. '42), Asst. Engr., Corps of Engrs., War Dept. (Res., 213 North New Hampshire Ave.), Los Angeles, Calif.

KENMIR, RUSSELL COLLINGWOOD (Assoc. M. '42), Chf. Insp., J. M. Montgomery & Co., 306 West 3d St. (Res., 3342 Lowell Ave.), Los Angeles, Calif.

KENNEDY, RALPH WALTER (M. '42), Res. Director, Widmer Eng. Co., Box 658 (Res., 1217 Chickasawba), Blytheville, Ark.

KING, HENRY ROYAL (M. '42), Senior Civ. Engr., The San. Dist. of Chicago, 910 South Michigan Ave., Chicago (Res., 1214 Central St., Evanston), Ill.

KNOOP, WERNER CALDWELL (M. '42) (Anderson & Knoop), 329 Gazette Bldg. (Res., 6 Onark Point), Little Rock, Ark.

KNOWLTON, EZRA CLARK (M. '42), Vice-Pres., Utah Sand & Gravel Products Corp., Salt Lake City (Res., Cottonwood Lane, Holladay), Utah.

KOCH, ROY DEFORIS (Assoc. M. '42), Senior Insp. of Constr., Bureau of Yards and Docks, U.S.N., Box 112 (Res., 1022 Second St.), Morgan City, La.

KRAPP, LEO FRIEDMANN (Jun. '42), Ensign, U.S.N., 4652 Hamilton Ave., Cincinnati, Ohio.

LEE, ROBERT EDWARD (M. '42), Senior Engr., U.S. Engrs., 613 Connecticut Blvd., East Hartford, Conn.